THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XXI.—NO. 515.

THE USE OF SECONDARY BATTERIES.

THE policy of supplementing an installation of dynamo machinery for electric lighting by the addition of secondary batteries is one which we have for a long time past strenously advocated. It has met with many opponents both here and in America. The most prominent of its enemies in the States was Mr. Edison. Evidently that gentleman has at length perceived reasons for changing his opinions respecting secondary batteries. In a circular which it has issued to its score or so of subsidiary companies, the Edison Electric Light Company announces that it has for some time past been negotiating with the Electrical Accumulator Company with a view to securing for its licensees and isolated customers the advantages, upon suitable terms, of a good storage battery. There is no doubt, the parent company thinks, that such a battery will, under many conditions, prove an important economic acquisition to an electric plant, and, while leaving it optional to the subsidiary companies to enter into agreements similar to that which it has itself signed with the Electrical Accumulator Company, it endeavours to impress them with the practical importance of so doing, and says that as a shareholder in each company it desires that they should do so. Of course this desire, so couched, amounts almost to a command, and there is little doubt that the many Edison illuminating companies spread over the States will quickly follow in the footsteps of their progenitor. It need scarcely be said that we approve of this complete change of front, and regard the act as one of great wisdom. By working the dynamos during the daytime for charging a set of secondary batteries a central station practically duplicates its power and its ability to supply customers, without making any addition to its machine plant. The full output of a central station is often in constant demand, and through a variety of circumstances it is frequently inconvenient or impossible to increase the area of the station or the generating plant. Moreover, when the light is not required, the condition prevailing through the greater part of the twenty-four hours, the machinery stands idle. The outlay upon the secondary batteries necessary for carrying out the scheme we have advocated need not be large, and the result would be that the company would be in a position to supply a much larger number of customers, and to thereby considerably add to its revenue.

It is possible that the development of secondary generators in the States, especially the part which Mr. Westinghouse has taken in that development, has largely influenced Mr. Edison, or his directors, in arriving at their decision to employ secondary batteries on a large scale. But whatever the reason, we are pleased to be able to chronicle the fact, for it will have an important bearing upon the future of the secondary battery industry in America, and probably, by reflection, but to a lesser degree, in this country also. It is unassailable that secondary batteries are capable of doing all that transformers may accomplish, and they furthermore possess the great advantage of storage capacity.

For the information of English readers who may not be thoroughly acquainted with American industries, we may state that the batteries referred to in the circular of the Edison Company are none other than those known in this country as the E.P.S. batteries, the Electrical Accumulator Company having been formed in the United States for the express purpose of working the patents of Faure, Sellon and Swan, under arrangement with the English Electrical Power Storage Company. This matter of secondary battery manufacture is a growing one, and an immense future may be predicted for it. Some idea may be formed of the magnitude which the business has already attained in the United States, when it is stated that one contract taken for the delivery of cells last month will alone yield £50,000. It will be interesting further to mention that great progress is now being made in Austria also. The Imperial Continental Gas Association has received upwards of 100 tons of E.P.S. battery plates from the English company, and has recently given a large order for the batteries to the Anglo-American Brush Corporation, which has established a large factory in Vienna for their manufacture as licensees of the Electrical Power Storage Company. Altogether, our readers will have little hesitation in concluding, with us, that the shareholders of this last-named company have a very fair prospect before them.

POSTAL TELEPHONIC CHARGES.

THE resolution which was adopted at a meeting of the Associated Chambers of Commerce at Exeter last week, with reference to the necessity for some further reductions in the telephonic charges made by the Post Office, is certainly entitled to the most careful consideration of the Postmaster-General. In the interests of trade and commerce the wider extension of the telephone movement is, it must be universally conceded, a consummation devoutly to be wished; yet telephonic progress in this country has been sadly retarded through official interference with private enterprise, in pursuance of a monopoly and the immoderate charges imposed by the department on its own *clientèle*. As Mr. Simpson, of Hull, pointed out, the telephone at a moderate charge is sure to become a success in towns where there is really some use for it. The speaker's statistics on this point were very convincing, for it appears that while in Christiania there is a telephone to every 70 of the inhabitants and in America one to every 125, the commercial port of Hull, with its important interests, can only boast of one to

every 2,000. Who can doubt that high prices have much to do with this surprising neglect of such an important means of inter-communication? The telephone charges in Berlin amount in English money to about £7 10s. per annum; while in London they reach £12 or £13. And the facilities in Berlin are probably greater than in the metropolis, for even such a low charge as £7 10s. entitles subscribers to communicate with Potsdam, 20 miles distant. Utter stagnation must be the inevitable result of the present lamentable want of enterprise on the part of the Post Office authorities. In Newcastle and district during the past two years the Post Office has only added eight persons to its list of subscribers, while the telephone company has secured over 330 during the same period, its charge being only £9 as against the Post Office £12. A strong opinion exists that a public department ought to deal liberally with the taxpayers, and if only on that ground Mr. Raikes would not be ill-advised if he took immediate steps towards reconstructing the whole telephonic system under his control.

MR. CHARLES MALTBY NEWTON'S battery may be an excellent invention, and "The New Electric Light Syndicate, Limited," which at present owns it, may be actuated by the most honourable and philanthropic motives in endeavouring to impress the public with its merits, both as a speculation and as a useful means of satisfying the cry for "more light." Whether this be so or not, a curious course has been taken to procure capital for putting the invention on the market. Advertisements recently appeared in the papers, to which was affixed the signature "Ajax," offering for sale shares in the New Electric Light Syndicate. "Ajax" *was* the New Electric Light Syndicate, or its secretarial representative, who generously promised purchasers 50 per cent. profit. Our spirited contemporary the *Financial News*, ever ready to expose either fraud or humbug, called for explanations, and was favoured with a letter from the secretary to the syndicate and the latter's prospectus. Mr. Maude, the secretary, assured our contemporary that every investigation on the part of intending investors was courted, and adduced, as a proof of the value of the battery, an account of it which appeared—in the ELECTRICAL REVIEW for June 24th last? No; Mr. Maude knew his business, so he sent a description of the invention given by a paper which was utterly incompetent to form an opinion respecting it. Speaking of the prospectus, the *Financial News* says:—"From the latter we learn that the company has been formed, with Mr. C. Maltby Newton as a director, to acquire a primary battery invented by Mr. Charles Maltby Newton. We learn, further, that 'a portion of the British patent has been sold for a considerable sum, which will permit of the distribution of a handsome *cash* dividend during the present half-year,' and, the company having thus ample money, 'invites applications (which can be made in the form of a letter) for 150 shares of £10 each, *funds being now required* for the purpose of securing the remaining foreign and colonial patents at once.' 'Ajax' is a little mixed apparently, otherwise, 'funds being now required,' he would use the 'considerable sum' for the purposes of his company, instead of paying 'cash dividends' with it. On the whole, Mr. Maude's explanation and Mr. Maude's prospectus make his case rather worse than it was before. We should advise investors to let this Maude go into the garden alone."

WE were recently informed by a friend that certain well-known firms who were using the electric light in large works had found that the younger illuminant was cheaper to them than gas had been. This, of course, was an item of much interest to us, and we desired to obtain particulars and definite figures to lay before our readers. With this view we wrote to one of the firms mentioned, asking them if they would favour us, for publication, with comparative facts and figures to show the relative cost of lighting by gas and by electricity. To our communication we received this courteous reply:—"Dear Sirs,—We are in receipt of your favour of yesterday's date, but confess we are at a loss to understand why you should expect us to go to the trouble and expense of sending you such information as you ask for. There are a great many *public* works and buildings at present lighted by electricity, and we should recommend your applying to them for the information you are requiring." Although we had anticipated a totally different kind of reply to this, we are, of course, much obliged to our correspondents for their kind and gratuitous advice to apply to the public works and buildings which are lighted by electricity for the information we require. Unfortunately, however, we do not believe the public works and buildings referred to possess the information we require, and therefore we have not thought it worth while to apply to them. It was our desire to place before our readers—at no one's expense but our own—positive facts as to the comparative cost of electric and gas lighting in large private works and factories, and we, as we thought and still believe we were justified in thinking, made application to the persons whom we deemed best able to afford us the information. We appear to have been mistaken in our estimate as to the amount of courtesy the firm of Brown, Marshall's & Co. were capable of displaying, and are heartily sorry that we troubled ourselves to write to them. We should still, however, be glad of the information, and if any reader can supply it he will have our thanks.

THE *Australasian and South American*—a New York journal devoted to commerce—in its issue of June 24th last, gives a capital illustrated account of the Thomson-Houston system, its factory, and a general outline of a few of the more important of its central lighting stations in America. This company appears to be doing the largest electrical business in the United States, if not in the world; and notwithstanding the fact that within the last year the capacity of its manufacturing facilities has been doubled, new factories are still in process of construction, which will more than double the present output. The system comprises not only arc and incandescent apparatus, but a full line of motors from ½ to 25 horse-power, or more if necessary.

MR. HUGH WATT will yet live to regret that he has turned his 'prentice hand to inventing if all the representatives of the daily press are as particular in their description of his new dynamo as the worthy reporter of the *Globe*. In this rosy hued journal we read that the machine gives over 130 *ampere hours* at 65 volts. Verily Mr. Watt's claim that his invention will revolutionise the electric lighting industry is about to be fulfilled.

THE HISTORY OF THE PHONIC WHEEL AND ITS APPLICATION TO SYNCHRONOUS MULTIPLEX TELEGRAPHY.

By PAUL LA COUR.

(Translated from the Danish.)

(*Continued from page* 333.)

IN my pamphlet on the Phonic Wheel ("La Roue Phonique," of 1878), pages 16, 17, I have described different ways in which an oscillating tuning fork may be made to alter its time of oscillation somewhat, namely :—

1. "By making the contacts stiffer, or by approaching them to the tuning fork, the number of oscillations is increased."

2. "By approaching the poles of the electro-magnet to the tuning fork the number of oscillations is reduced."

3. "By increasing the current, which keeps the tuning fork in oscillation, the number of oscillations is reduced."

4. "By increasing the temperature of the tuning fork the number of oscillations is reduced."

I saw at once that these remarks would be of scientific interest, and I had therefore noted them already in 1878; but I did not at that time think of using them practically for the synchronism, which I at first proceeded with as described in the former article. This synchronism was inconvenient, however, in that it was sometimes difficult to start wheel No. 2 in the right manner, and several attempts were often made before the experimenter succeeded in bringing it in such accordance with No. 1 wheel that the six negative impulses just happened in those moments when the revolving arm touched the six metallic segments, which were in connection with the electro-magnet of the tuning fork. The experiments between Fredericia and Nyborg certainly showed that ordinary telegraph operators could easily acquire this expertness, and also that the wheels moved undisturbed from morning till night when once properly started. But it is evidently better when the system can regulate itself automatically, and it therefore occurred to me in April, 1881, to utilise some of the above-named variations in the number of oscillations to attain this object. This is the invention which I, in my former article, called the *improved synchronism*, and which I patented in England on the 7th October, 1882, filed on the 3rd of April, 1883. The patent specification is a very simple one, and being the principal historical document relating to the improved synchronism, I consider it of sufficient interest to give it here. It runs as follows :—

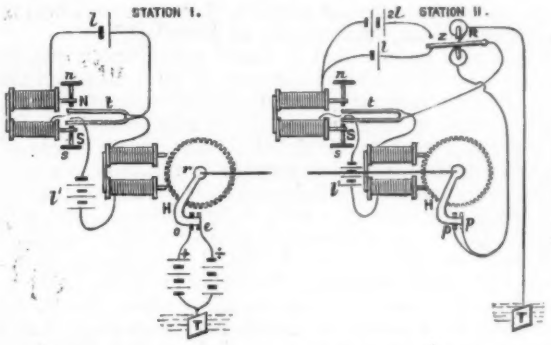
"An apparatus for obtaining synchronous movement according to this invention consists principally of a vibrating body, such as a tuning fork permanently vibrating or oscillating by automatic electric intermittent action, and thereby transmitting an intermittent or undulating electric current and of a wheel subject to oscillation or vibration under the influence of the said current. The rotation of this wheel under these circumstances being exceedingly regular, the current is applicable to various purposes, such, for example, as to establish synchronous movements at two or more stations connected by a telegraphic line. The more the oscillating or vibrating body (hereinafter denominated a tuning fork) is attracted, the longer is the period or rate of its oscillation and the slower does the wheel consequently move. Thus the time of oscillation can be lengthened, for instance, by (1) moving the attracting poles nearer to the branches of the tuning fork, or (2) by letting a stronger current act upon the tuning fork to keep it in motion.

"The former can be done simply by applying through the poles, N and S, of the electro-magnet, two screws of iron forming polar extensions. When these are screwed nearer to the branches of the fork or farther therefrom, the time of vibration or oscillation of the fork will accordingly be either somewhat prolonged or shortened, and the wheel will consequently turn somewhat slower or somewhat quicker. This method of regulation can be adapted to apparatus at various stations, connected by a telegraphic line, when it is easy to tell if the movements are synchronous. If the synchronous movements are used, for instance, to produce pantelegraphy, it can directly be observed at the receiving station if the writing or the drawing stands correctly, or, still better, if a vertical line on the original for instance along the border of the same, appears as a vertical line at the receiving station. If the line is reproduced in an oblique position, bending to the one or to the other side, it proves that the revolution of the phonic wheel is too quick or too slow. The screws forming the polar extension can then be regulated, until the copy of the vertical line also becomes vertical.

"By the latter of the above-mentioned methods for altering the time of oscillation of the fork, namely, by varying the strength of the current, which causes the fork to oscillate, one can obtain absolute synchronous movements in the following manner.

"Referring to the accompanying sheet of drawings, at station No. 1 the fork, *t*, is kept in automatic movement by a local battery, *l*. The circuit of a second local battery, l^1, is thereby intermittently completed, and the phonic wheel, *r*, can thus be kept in uniform rotation, one tooth passing at each oscillation or vibration of the fork. At station No. 2 the fork, *t*, is in a similar way kept in automatic movement by means of the local battery, *l*.

"Thereby the current in a second local battery, l^1, becomes intermittent, and the phonic wheel, *r*, has a corresponding speed of rotation. At station No. 2 there is also a third local battery, l^2, stronger than the first, l^1, and capable of being thrown into circuit in place of the first by the tongue of a polarised relay, R. The fork, *t*, is now tuned at station No. 2 by means of the polar extensions, N and S, so that the phonic wheel at No. 2 turns quicker than at No. 1, when the fork at No. 2 is operated upon by the first local battery, *l*, whilst the wheel at No. 2 turns slower than the wheel at No. 1 when the fork at No. 2 is operated upon by



the third local battery, l^2. To each of the wheels is attached an arm, H and H, which is in electric connection with the telegraphic line. The arm, H, at station No. 1 touches at each revolution two contact pieces, *e* and *o*, which are in connection respectively with the negative and positive poles of two batteries, the other poles of which are conducted to the earth, T. Consequently there is produced at each revolution a negative and positive undulation of short duration. At station No. 2 there are two corresponding contact pieces, *p* and *p*, from which a circuit passes through the convolutions of the relay, R, to the earth, T. On putting both wheels in motion and placing the tongue of the relay in such a position that the fork at No. 2 is operated by the first battery, *l*, the wheel at station No. 2 will turn quicker than the wheel at No. 1. Thereby the arm at No. 2 will gradually overrun the arm at No. 1 so that the former touches its contact pieces at the same moment that the latter touches its positive contact piece, *o*. The tongue of the relay stands still, however, until the arm, H, at No. 2 after some more revolutions touches its terminal, *p*, *p*, at the very same moment that H, the arm

at No. 1, touches *e*, the negative terminal. The negative current wave will throw the tongue of the relay against the other contact and thus the third battery, l^2, is substituted for the first, *l*, whereby the wheel at No. 2 turns slower.

"After some revolutions the arm, H, at station No. 2 will again touch the contact, *p*, *p*, at the same moment the positive wave from No. 1 arrives to move the relay tongue whereupon the first battery, *l*, is again replaced, and so on. Thus the relay, R, will cause the wheel at No. 2 to move on the average just as quickly as the wheel at No. 1, and for that purpose the telegraphic line is only in use during the short time the arms, H and H, at the two stations are passing respectively over the contact pieces, *e*, *o*, and *p*, *p*. During the rest of the time the telegraphic line can be used for various kinds of telegraphy, the arms, H, being available during the remainder of their motion to send and receive different currents from No. 1 to No. 2, or from No. 2 to No. 1.

"Or there can during some fractional parts of the revolution be sent currents in one direction, and during others in the opposite direction.

"Thus the synchronous movements can be utilised in different kinds of telegraphy.

"Having described the nature of the said invention, and the manner of carrying it into practical effect as communicated to me as aforesaid, what I claim is :—

"1. Utilising the variable attraction between an electro-magnet and a permanently vibrating or oscillating body, such as a tuning fork, for the purpose of altering the period or rate of vibration or oscillation of the said body, the greater attraction giving the slower rate of vibration or oscillation substantially as described.

"2. Varying the velocity of rotation of the phonic wheel by altering the distance between the polar extensions of the electro-magnets and the branches of the fork ; or by varying the strength of the current that operates the tuning fork, substantially as described.

"3. Regulating the velocity of rotation of the phonic wheel at the receiving station by means of a current from the transmitting station acting through a relay, whereby the strength of current operating the tuning fork at the receiving station is changed as required to render synchronous the rotation of the phonic wheel at the two stations, substantially as described."

It is well known that a patent specification should contain a full and clear account of all details that are necessary to make the invention fully understood, and, if required, to carry it out practically ; but if it, for example, has been stipulated that a certain piece of wood may be fastened to another by means of a screw, then one cannot be bound to specify, "this might also be done by means of a nail, or by means of glue, &c., &c." It must be sufficient that the "claims" specify, that the one piece of wood should be fastened to the other when the manner of fastening is indifferent.

When I am going to synchronise wheel No. 2, by varying its velocity, so that it runs sometimes faster and sometimes slower than No. 1, I say, first, that "the time of oscillation can be lengthened" . . . (2) "by letting a stronger current act upon the tuning fork to keep it in motion" ; secondly, I describe specially how this can be done by letting a relay insert either a weaker or a stronger local battery to act upon tuning fork No. 2, and finally I stipulate :—"2. Varying the velocity of rotation of the phonic wheel . . . . by varying the strength of the current that operates the tuning fork." It is, therefore, not necessary for me to name all the modes, known to everyone, in which this can be accomplished, and when anyone uses another method of altering the strength of the current, he is not, therefore, entitled to be called the inventor of the method, or to patent the same.

Further, if a man invents an ingenious lock and patents the same, another person has no right to patent a safe upon which he attaches two of these locks, because he asserts that the former inventor has only patented one lock, and that greater security is obtained when the safe is provided with two such locks !

It is such alterations that Delany made upon the description which I sent Mr. Jones, under whose instructions Delany worked, and it was these that he, as I mentioned in my former article, patented in the United States and in Europe, in which latter quarter of the globe he had no right whatever to do so. He took out so many patents that it would be most trying work to go through them all, and also exceedingly painful to me, because he calls my invention his with the most unblushing impudence. If it be of interest to anyone to see how far this can be carried, he only needs to buy the specification of Delany's patent in Great Britain, No. 4,787, and to compare its contents with mine, as reprinted above, No. 4,779. It will, for instance, be seen how very minutely Delany (page 7, 27—55) describes the phonic wheel, even to the mercury reservoir (page 7, 40—42), without mentioning my name in connection therewith, or the name of the phonic wheel ; nor does he make any allusion to the latter as not being his own invention. It will further be seen how Delany pretends to have discovered the important law upon which the synchronism is based, and which I have given above ; he writes (page 9, 11—13) :—"In explanation of the fact that an increase in the strength of the fork-magnets causes the time of a fork to vibrate more slowly, I desire to say that I have demonstrated it frequently by experiment." Such an assertion from the individual who through Mr. Jones had received my above-named specification is sufficiently characteristic, so that I need not commence an exhaustive criticism of his inventions in this paper ; but I must confess that when I first noticed that the Franklin Institute of Philadelphia took an interest in this matter I had a hope that it would throw new light upon it. The way in which this was done was reported in this paper on the 26th August ult., and it is therefore unncessary for me to repeat the historical part of this question ; but this article of the 26th August further shows that the report issued by the scientific committee of the Franklin Institute contains such errors that one does not feel any greater inclination to open a discussion on it than on Delany's patents. I shall only recall the fact that the committee denies what the Director of the Danish Government Telegraphs expressly remarks with regard to the synchronism being good, and also what the article in the ELECTRICAL REVIEW, mentioned above, strikingly denotes as nonsense, namely, that the committee says that Delany prevents the instruments from diverging from absolute synchronism. Such absolute or mathematical synchronism is not to be found in the material world ; synchronism can only be obtained by continually correcting the error, and it is proved that the phonic wheel is such a perfect instrument that there is no occasion whatever for correcting it three or six times for every revolution or to let the wheels mutually correct each other, just as little as it is practical to fix six patent locks aside of one another. This is only loss of time. It appears that the wheel sometimes can make two, three, or four revolutions before so much disagreement arises that the sensitive relay is thereby affected. The committee seems to hold the childish view, when it spends many words in letting my wheel No. 2 "go too slowly," "come too far behind," "be regulated," "go too quickly," "reach the proper place," &c., while allowing Delany to maintain synchronism by "preventing it from getting out," that mine "is not even close enough to be approximate synchronism," while Delany's is perfect.

As, however, the article in the ELECTRICAL REVIEW of August 26th has thrown the right light upon this report generally, I don't intend to go over the same ground here. Be it sufficient to deal with those points which the committee looks upon as the principal parts of Delany's improvements. It says :—

"Delany having found La Cour's method impracticable, abandoned it, and set about constructing a new system by which each wheel kept the other from running irregularly, not by bringing it back after it had got out of synchronism, but by preventing it from getting out, the slightest tendency to go out being immediately checked. This was done by the introduction of resistances into the fork circuit, which, being instan-

taneously introduced, operated immediately. This was a radical change in three particulars :—*First*, in the mutual correction by the two wheels of each other's movement ; *second*, in the application of the correction before the wheels were out of synchronism ; and *third*, by the instantaneous introduction of *resistances* into the circuit."

It gives me great pleasure that the scientific committee, whose principal task seems to be to support Delany, has undertaken to point out what his inventions really consist in, for I have searched in vain for them through his many patents. After the issue of the Franklin Institute's report it is much easier to see Delany's merits. These are, as the report says :—

"First, in the mutual correction by the two wheels of each other's movement." This is exactly the same as to apply two locks instead of one. If each separate lock be not safe it is of no avail, and if the one lock be absolutely safe the arrangement is only unnecessarily complicated. Whether the one lock which I had applied be absolutely safe, we shall see presently.

"Second, in the application of the correction before the wheels were out of synchronism"—this is, as already expressed by the REVIEW, nonsense.

"Third, by the instantaneous introduction of *resistances* into the circuit." This is what I have invented and claimed thus :—"By varying the strength of the current that operates the tuning fork." Whether a nail or a screw be used is quite immaterial.

The only remaining question is, whether my synchronism be exact and reliable.

As already above mentioned, I have not expressly gone in for telegraphy, but principally been engaged in producing a perfect synchronism. I have therefore not applied to telegraphic administrations, as these, as a rule, want the system completely in working order ; but I have been brought into contact with some private gentlemen, who have had plans of their own as to using the synchronism. Amongt these I may name Mr. Cassagnes, in Paris, whose steno-telegraphy is already known by many. When I heard that Delany during his visit to Europe in 1886 had declared my synchronism impracticable, and I did not receive any account of his reply to the committee, I presumed that he had in this expressed his views similarly, a supposition that ultimately proved to be correct. I therefore determined to substantiate that my synchronism had proved good on long lines, and after application to Mr. Cassagnes I received a declaration, which I immediately dispatched to the Franklin Institute, and which is to be found in the report in French, as well as in the following translation :—

[COPY.]

Ministry of Postal Affairs and Telegraphs,
Paris, the *4th January*, 1887.

Monsieur Cassagnes, Civil Engineer,
18, Rue Lafayette, Paris.

Sir,—Conformably to the desire expressed in your letter of the 1st December, I send you, annexed, an extract from the Reports addressed to the Government, in consequence of the experiments in the line of your system of steno-telegraphy.

Receive, sir, the assurance of my distinguished consideration.

The Minister of Postal Affairs and Télegraphs,
GRANET.

Extract from the Reports on the Experiments in Telegraphic Transmission made by means of M. Cassagnes' steno-telegraphic system.

Last Series of Experiments, *October*, 1886.

The last series of experiments in multiplex steno-telegraphy, made by utilising the previous composition, and automatic transmission, has furnished the following results :—

We can transmit per minute and per section from 125 to 145 words ; as for the number of transmissions or sections it depends on the resistance and the capacity of the line. A triplex apparatus, or of three sections, might be utilised up to 500 to 600 kilometres (310,675 miles—372,810 miles), a duplex apparatus up to 700 or 800 kilometres (434,945 miles—497,000 miles), or, perhaps, beyond ; but in the experiments made on a circuit of 900 kilometres (559,215 miles), the correction was not always efficacious, and injurious interferences resulted. The accomplishment per hour would then be about 25,000 words between Paris and Lyons, and from 15,000 to 16,000 on longer lines, every reservation being made as to what concerns the stenographic language forming the basis of the system.

I attest as a certified copy the preceding extract from the Report of the French Telegraph Administration.

I certify, moreover, that in my steno-telegraphic apparatus, the results of which on the line are officially stated above, the only synchronism of which I have made use, and which has not failed to operate in the most satisfactory manner in French circuits of 800 kilometres, is the synchronism by means of the phonic wheel of Monsieur Paul La Cour, d'Askovhus (Denmark) as it was patented in France by M. La Cour the 11th October, 1882.

A. CASSAGNES.

Paris, the *2nd March*, 1887.

How does the committee now overcome this difficulty ? All it says about this in the report is as follows :—

"The especial object of La Cour's letter of March 12th, 1887, was to call attention to the fact that G. A. Cassagnes, a French engineer, successfully operated his synchronous autographic system, which he calls steno-telegraphy, by means of his (La Cour's) synchronism, as described in La Cour's patent of October the 7th, 1882. The committee found in the Memorial Library of the Institute a copy of a pamphlet, issued by Cassagnes in 1886, descriptive of his system of steno-telegraphy, which relates that the system is based upon the synchronism produced by La Cour's phonic wheel. Drawings of the apparatus are given in the pamphlet, which show *not* La Cour's system of two batteries of different strength, but Delany's method, 'instantaneous introduction of resistances.'" The drawing shows no other arrangement of what the committee calls "Delany's method" than this, namely, that the strength of the current in fork No. 2 is not varied by different electromotive forces, but by different resistances. This is, however, quite an unessential matter ; one simply chooses what seems most convenient at the time, as in the case of a screw or a nail. I had myself used both these and still more ways of altering the strength of the current in the circuit of fork No. 2 long before I took out my patent, and I have expressed this clearly enough in my "claims," which say, "by varying the strength of the current that operates the tuning fork."

These are the main points in Delany's inventions. According to the committee the most important of the "minor details" consists in neutralising the injurious effects of the static charge ; and the report adds : "La Cour ignores it in his patents." To this I reply : Yes, that is quite natural, because my invention has solely for its object perfect synchronism, without special regard to practical telegraphy, and for this synchronism I only use two small metallic segments alongside each other upon wheel No. 1 (the one segment supplying the revolving arm with positive electricity, the other with negative), and at station No. 2 I employ two corresponding metallic segments for receiving the correcting current. This is all I used for synchronism. All the other metallic segments I leave for telegraphic purposes, and it is the business of the engineer to provide for the necessary discharges of the static charge.

I regret that a report like this should have been issued by a scientific institute that bears the name of Franklin. In conclusion, I must therefore counsel the Institute to consider carefully who they appoint on special committees, and as I still cannot believe that all the four members of the committee can possibly have taken the trouble to make themselves familiar with the subject, but have allowed themselves to be led by a few whom they have relied upon, I shall also advise these to be careful as to whom they, in their turn, depend upon. I shall thus inform them that I, in an exchange of letters with one of the members of the committee, namely, Prof. E. J. Houston, sent him in a registered letter (and it is not returned) the original document from the Director of Danish Government Telegraphs, of which I gave a reprint in my former article, with the request that he would find "a convenience for truthfully publishing the veritable state of things." I sent him both the document, which was in Danish, and the translation, but I have never heard anything of it since. I wonder if he ever communicated this to his colleagues on the committee ?

THE P. AND O. COMPANY'S NEW STEAMER "VICTORIA."

THE electric lighting on board this vessel is interesting by reason of the low rate of speed at which the dynamos are driven. Hitherto the company has used almost exclusively the frictional gear contrived by Mr. J. S. Raworth, and largely introduced by Messrs. Siemens Bros. This gear has given the most unqualified satisfaction, applied as it has been to small machines, but it was felt that for a very large dynamo capable of running 400 to 500 lights such a plan of driving would be altogether unsuitable, and it occurred to Mr. C. Hall, A.M.I.C.E., the company's electrical adviser, who we must congratulate on the success of his innovation, that the best method of meeting the difficulty was to dispense altogether with gearing and bring the speed of the dynamo down to that of the engine. In view of the length of voyage a fast-running engine is not admissible on board these steamers, and it was finally decided to employ a compound engine by Tangye's, of Birmingham, running at a speed of 200 per minute, and the problem then remained to build at a fairly economical rate, and within reasonable dimensions, a dynamo capable of giving the requisite current, and an electromotive force of 100 volts at a speed not exceeding 200 revolutions. This task was undertaken by the Anglo-American Brush Company, and has been satisfactorily accomplished, the speed of one machine, when doing its full output, being 195, and that of the duplicate machine 204 revolutions per minute.

The ship is wired throughout in the best style on the single wire system, and about 450 lamps are in daily use, besides which a Brockie-Pell automatic lamp and a Sautter-Lemonnier projector are carried for use in the Suez Canal.

On a recent occasion we had an opportunity to inspect the ship, which is one of the most magnificent specimens of naval architecture ever brought into the Thames, and rivals closely the huge vessels of the Liverpool fleet both in speed and size.

Her dimensions are—465 feet long, 52 feet beam, 37 feet depth (keel to spar deck); tonnage, 6,268 tons; horse-power, 7,000; speed, 17 knots maximum. The engines are on the triple expansion principle, having cylinders 40, 63 and 100 inches diameter with a 6 feet stroke, and the boilers are of extra capacity and pressed to 150 lbs. per square inch. The screw propeller is 20½ feet diameter, and has blades of manganese bronze, a metal which does not corrode in salt water and is as tough as steel.

There is a very large provision of bilge pumps in case of leakage, fire hydrants throughout the main deck, and steam pipes in the holds for annihilating any fire which may occur amongst the cargo.

The cranes and winches are all hydraulic, supplied by Lord Armstrong's firm at Elswick, and the apparatus is contrived to be capable, if required, of charging torpedoes with compressed air to 1,500 lbs. per square inch, in view of the employment of the ship as an armed cruiser, for which purpose she is likewise fitted with gun platforms in accordance with the Admiralty requirements.

A very complete system of mechanical ventilation, designed by Mr. Mannel, the company's superintendent engineer, has been fitted up by Messrs. Muir and Caldwell, of Glasgow, who also supplied the steering engines. There are in addition two large refrigerating machines by Haslam, of Derby, which are capable not only of preserving the ship's own provisions, but also a large meat cargo if required.

We may add that the ship was built and engined by Messrs. Caird & Co., of Greenock, and it is a splendid example of the expedition with which work in private shipbuilders' yards is carried out that the whole was completed, and the ship present at the Naval Review, in about 10 months after the order for her was given.

The *Victoria* sailed on the 1st October for Bombay as a special steamer for an Indian trip; she will remain 17 days at Bombay and bring her passengers back to England by the 8th December, and we are glad to hear that this most enjoyable trip has been liberally patronised by the travelling public.

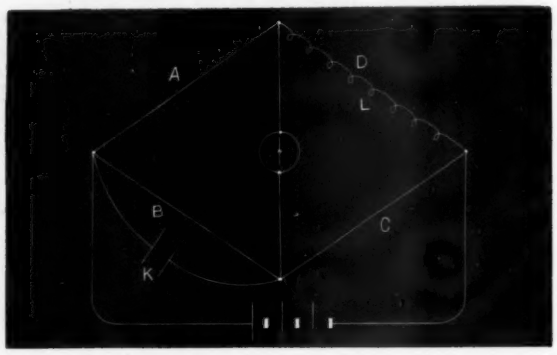
SELF-INDUCTION AND ITS MEASUREMENT.

By E. C. RIMINGTON.

(*Concluded from page* 341.)

Maxwell's Method.

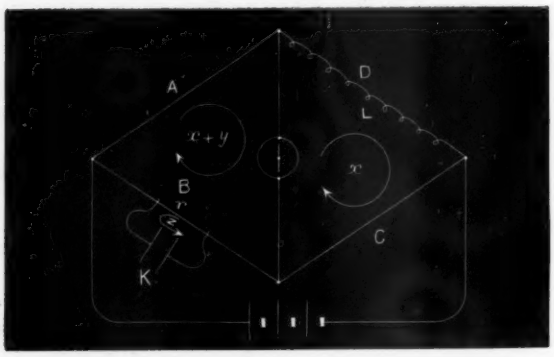
In a Wheatstone bridge D is the coil whose coefficient of self-induction, L, is to be measured. The armatures of a condenser of capacity, K, are connected to the ends of the arm, B. There are keys in the battery and galvanometer branches. An ordinary balance for permanent currents is first obtained in the usual manner, so that A C = B D. The resistances, B and D, are next adjusted so that there shall be no throw on the galvanometer, when its key is depressed before that in the battery branch. Then, as will be shown in the next method, L = K B D.



As D cannot in general be adjusted, if a throw is observed, B must be altered and a permanent balance again obtained by the adjustment of A or C; and so on until a balance is obtained whichever key is depressed first. This necessity makes the method extremely inconvenient and tedious.

The Author's Modification of Maxwell's Method.

The arm, B, of the bridge consists of a slide resistance, on which move two sliders connected to the armatures of a condenser of capacity, K, as shown in the diagram. There are keys in the battery and galvanometer branches as usual. Obtain a permanent balance so that A C = B D. Then adjust the position of the sliders until a balance is also obtained for transient currents. Let λ be the coefficient of self-induction of the galvanometer, and G its resistance. Let $x + y$, x, and z be the cyclic signs of the three meshes, as shown, according to Maxwell's notation, and let q be the charge on the condenser at some instant, t.



Then we have

$$(A + B + G)(x+y) - G x - r z + \lambda \frac{d(x+y)}{dt} - \lambda \frac{dx}{dt} = 0$$

$$(C + D + G)\, x - G\,(x + y) + L \frac{dx}{dt} - \lambda \frac{dy}{dt} = 0$$

Now $$z = -\frac{dq}{dt}.$$

Substituting this value in the above two equations and rewriting we obtain :—

$$(A + B + G)\,y + (A + B)\,x = -r\frac{dq}{dt} - \lambda\frac{dy}{dt}$$

$$-G\,y + (C + D)\,x = -L\frac{dx}{dt} + \lambda\frac{dy}{dt}$$

Hence

$$y = \frac{\begin{vmatrix} \left(-r\frac{dq}{dt} - \lambda\frac{dy}{dt}\right) & A + B \\ \left(-L\frac{dx}{dt} + \lambda\frac{dy}{dt}\right) & C + D \end{vmatrix}}{\begin{vmatrix} A + B + G & A + B \\ -G & C + D \end{vmatrix}}$$

$$\Delta y = -(C+D)\left(r\frac{dq}{dt} + \lambda\frac{dy}{dt}\right) + (A+B)\left(L\frac{dx}{dt} - \lambda\frac{dy}{dt}\right)$$

where Δ stands for the determinant forming the denominators in the value of y.

Multiplying by dt and integrating between the limits $t = \infty$ and $t = 0$

$$\Delta\int_0^\infty y\,dt = -(C + D)\left\{r\int_{q_1}^{0} dq + \lambda\int_0^{0} dy\right\}$$

$$+ (A + B)\left\{L\int_{x_1}^{0} dx - \lambda\int_0^{0} dy\right\}$$

x_1 being the permanent current flowing through D, and q_1 the charge on the condenser during the permanent state. Now $\int_0^\infty y\,dt$ is the quantity passing through the galvanometer, or Q.

Therefore

$$\Delta Q = -(C + D)(-r q_1) + (A + B)(-L x_1)$$

$$= (C + D)\,r\,q_1 - (A + B)\,L\,x_1$$

But $q_1 = K\,r\,y_1$, where y_1 is the permanent current through B and C.

Hence $$Q = \frac{(C + D)\,K\,r^2\,y_1 - (A + B)\,L\,x_1}{(A + B + G)(C + D) + G(A + B)}$$

This reduces to

$$Q = x_1 \cdot \frac{K\,r^2\,D - B\,L}{B(C + D) + G(B + C)}$$

since $$A\,C = B\,D \quad \text{and} \quad \frac{y_1}{x_1} = \frac{D}{C}.$$

Now, if there be no throw in the galvanometer, Q = 0.

Therefore $$K\,r^2\,D - B\,L = 0$$

or $$L = K\,r^2 \cdot \frac{D}{B}$$

If $r = B$ we have Maxwell's method and $L = K\,B\,D$.

Obviously it is unnecessary to employ two sliders; one armature of the condenser may be connected to the junction of A and B, or to that of B and C, and the other to a slider; by having B, however, composed of two slide resistances, the smaller one being equal to the resistance of one of the coils of the larger, and employing a slider on each, a much greater range of adjustment may be obtained. Another way of obtaining a more accurate adjustment is shown in the following two figures :

Two condensers, K and k, are employed, the former being of the greater capacity. If L is less than $K\,D^2$, the arrangement is as in fig. 1, if greater, as in fig. 2.

In fig. 1 B is the slide resistance, and the slider, S, is adjusted until a balance is obtained, then :

$$L = \frac{D}{B}(K\,B\,D + k\,r^2) = K\,D^2 + k\,r^2\,\frac{D}{B}$$

In fig. 2 A is the slide resistance and

$$L = K\,D^2 - k\,r^2\,\frac{C}{B}$$

This method may be rendered far more sensitive by the employment of a commutator similar to that

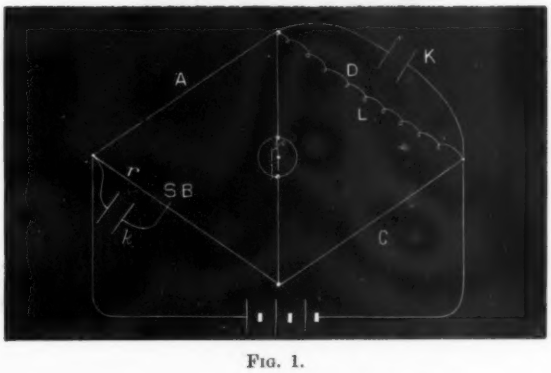


FIG. 1.

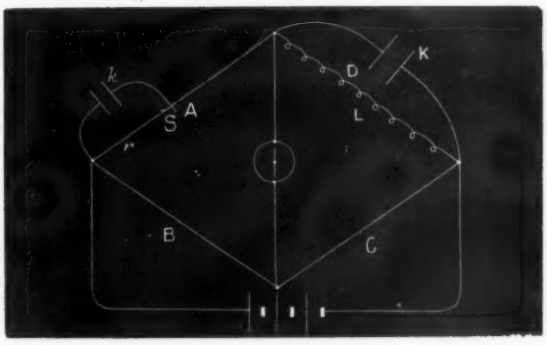


FIG. 2.

described in Ayrton and Perry's method, with the advantage that neither the speed of the commutator, nor the fraction of a cycle during which the battery and galvanometer are on together, need be known. For a further description *vide* ELECTRICAL REVIEW, Vol. xxi., p. 62.

With regard to the effect of capacity combined with self-induction Mr. W. E. Sumpner, in a paper read before the Society of Telegraph Engineers, has given the following convenient law :—

"In any network of conductors, if one of the branches be composed of a condenser whose terminals are shunted by a wire, with or without self-induction, and if the currents in the network vary from any cause from one steady set of values to another, the extra quantity of electricity which will pass through a galvanometer placed in any arm of the network, in consequence of the capacity, will be exactly as if the condenser were altogether removed and the self-induction of the wire were diminished by the product of the capacity of the condenser and the square of the resistance of the wire shunting it."

This may be easily shown thus :—

In the figure let C be a steady current flowing through r, and suppose the E.M.F. of the battery is varied so that the current C is altered to C_1.

Let x and y be the cyclic signs of the meshes at some time, t, during the variation, if q be the charge on the condenser at the same instant $x = \frac{dq}{dt}$

$$y\,(R + r) - x\,R + L\frac{dy}{dt} - L\frac{dx}{dt} = E$$

$$(R + r)\,y\,dt - R\frac{dq}{dt}\,.\,dt + L\,dy - L\,dx = E\,dt$$

$$(R + r)\int y\,dt - R\int dq + L\int dy - L\int dx = \int E\,dt$$

But $\int y\,dt = Q$ the quantity passing through the resistance, r; $\int dq = K\,R\,(C_1 - C)$; $\int dy = C_1 - C$; $\int dx = 0$.

Hence,

$$(R + r)\,Q - K\,R^2\,(C_1 - C) + L\,(C_1 - C) = \int E\,dt$$

$$Q = \frac{\int E\,dt}{R + r} - \frac{(L - K\,R^2)\,(C_1 - C)}{R + r}$$

Obviously if K were zero, or there were no condenser, the value of Q would be $\frac{\int E\,dt}{R + r} - \frac{L\,(C_1 - C)}{R + r}$.

Hence the effect of the condenser as regards the quantity passing through r is equivalent to that of diminishing L by an amount equal to $K\,R^2$.

The unit coefficient of self-induction.

It is well known that the dimensions of the coefficient of self-induction are those of a length. In the C.G.S. system of units, its unit would be the centimetre; in the practical system of electrical units, viz., the ampère, volt, ohm, &c., the unit of length is 10^9 centimetres, the unit of time being the second, the unit coefficient of self-induction would therefore be 10^9 centimetres or an earth's quadrant. It is, however, more convenient to call it the unit of resistance multiplied by the unit of time (since resistance has the dimensions of a velocity), or the "ohm second." Prof. Ayrton proposes that this name should be modified to "secohm." If the electrical quantities in the preceding articles have been expressed in units of the practical system, L must be in secohms. It must be remembered that, K, the capacity of a condenser must be expressed in farads; although the unit in actual use is the microfarad.

UNDERGROUND WIRES IN PARIS.

La Lumière Electrique in its issue of September 24th publishes the rules elaborated by the Paris Technical Commission of Electricity for the installation of electric lighting and electrical transmission of power by means of underground wires through the streets of Paris. This commission owes its existence to the prefectural decrees of August 13th, 1881, and July 14th, 1887.

We have not the space for a detailed account of the conditions laid down; the following extracts, however, may be of interest:—

Should the municipality consider it inconvenient to have the wires or cables placed in the sewers, they must be laid under the pavement in conduits of earthenware, masonry, or metal.

The contractor is bound to furnish complete plans of the proposed system, clearly showing the position of every branch wire and the number of lamps it is to feed, or in the case of supplying motive power the force must be indicated in horse-powers of 75 kilogrammetres.

No monopoly or exclusive privilege will be granted, and the municipality has the power to absolutely define and limit the district it may think fit to apportion to any contractor.

The tariffs which the contractor may apply must not exceed 0·06 francs per carcel-hour, or 0·60 francs per electrical horse-power. Should the municipality require the contractor for public lighting, whether of streets or of public or municipal buildings, he shall be obliged to do so at two-thirds of the lowest tariff charged to private individuals.

Except in such cases as are duly recognised by the Administration, the contractor may only use those machines, instruments, cables, &c., which have been constructed in France, and the proportion of foreign workmen employed must not exceed one-tenth of the total engaged. We do not observe among the rules any especial recommendation as to the type of cable or nature of insulating material. It seems to be inferred that in the sewers and conduits naked wires are to be permitted, the responsibility for damage to property, or failure of supply, resting upon the contractor. There are several clauses dealing with the fines to be imposed, and the penalties incurred, for neglect to fulfil the conditions laid down.

The regulations, on the whole, appear to be rather severe, the well-known propensity of French administrations to exercise a paternal supervision being well exemplified. No doubt stringent rules should be adopted for the protection of the public, but (as witness the case of the telephones) our neighbours are inclined to tie the hands of *entrepreneurs* with a host of petty and aggravating restrictions. The power to hamper and annoy is too frequently placed in the hands of men totally unfitted to wield an unrestrained authority.

Many of the conditions imposed, and the manner in which they are to be enforced, are admirably calculated to foster favouritism and underhanded dealings. The practical result without any doubt will be to place the contracts in the hands of the personal friends of the authorities, possibly to the disadvantage of the public. We have carefully considered the various articles of the regulations, and can come to no other conclusion.

We are glad to see that some definite form of legislation with regard to underground wires has been undertaken by the French authorities, but we think it a mistake that some regulations as to the insulation of the wires have not been adopted. If we are correct in assuming that naked wires are to be allowed in conduits, the failure of such a system is sure to ensue, no matter what so-called insulating composition may be used to surround the wires in the conduits or pipes.

THE WESTINGHOUSE ALTERNATING SYSTEM OF ELECTRIC LIGHTING.

(*Continued from page* 338.)

THE form of converter used, as originally designed, is shown in elevation in fig. 7, and in cross-section in fig. 8. The primary and secondary coils are separated and insulated from each other, and are disposed side by side as shown at P and S. After these have been wound upon a form into suitable coils and wrapped with insulating material, the inductive plates, A, which are in the form of a capital letter E, as shown in fig. 9, of thin sheet-iron with an insulating layer of paper applied to one surface, are slipped over the coils alternately from opposite directions, the alternate plates being interleaved with each other as shown at A. Thus the inductive core is composed of a mass of detached plates, each of which of itself constitutes a discontinuous magnetic circuit. The plates are insulated from each other by the paper, and as alternately arranged about the coiled conductors the mass of the core becomes symmetrically disposed about the mean axis of the conductors, a necessary condition for effec-

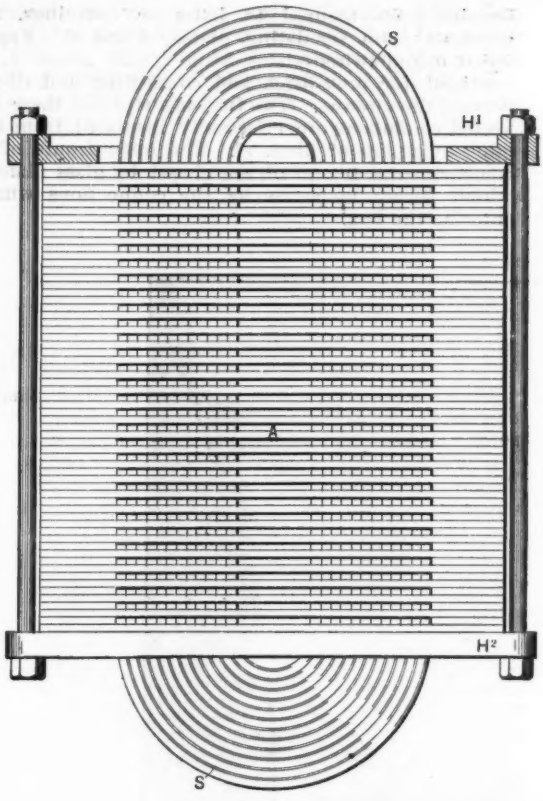


Fig. 7

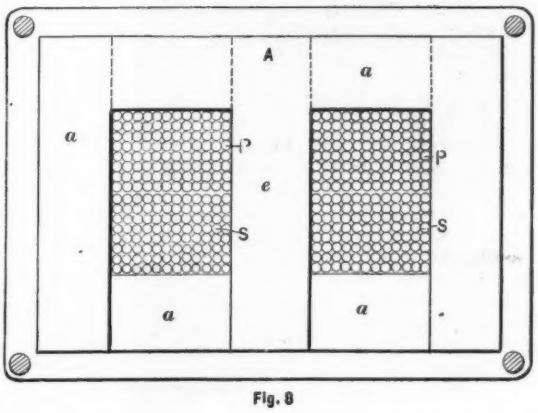


Fig. 8

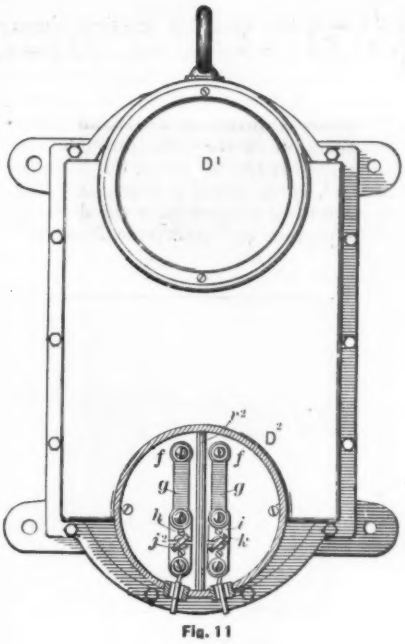


Fig. 11

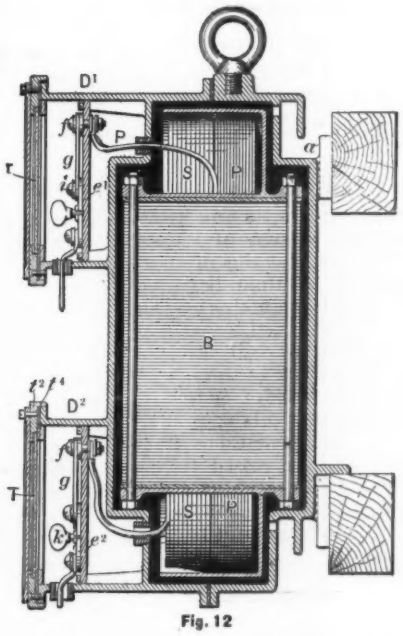


Fig. 12

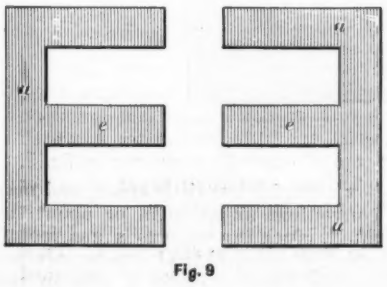


Fig. 9

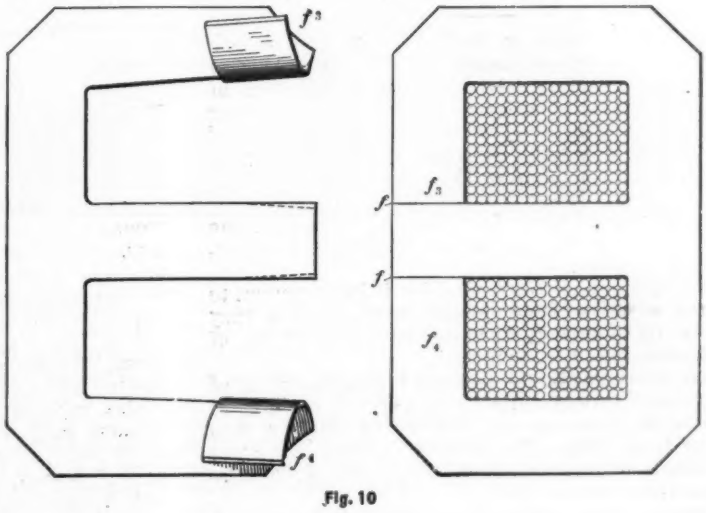


Fig. 10

tive work. The iron plates are securely bound together in a solid mass by end frames or heads, H^1, H^2, which are connected together by longitudinal bolts. A more recent and in some respects preferable form of plate for the cores is shown in fig. 10, and for convenience of construction is the one now generally preferred. Each plate is in one piece, but is cut at f, f, the ends, f^3 and f^4, being readily bent back as shown to permit the plate to be slipped over the coils.

In order to protect the converter from mechanical injury, as well as from dampness, and also to avoid the possibility of contact with wires carrying currents of high potential, it is enclosed in a cast-iron case or box, made in two parts, and adapted to be secured to any convenient vertical support. Fig. 11 is a front view, and fig. 12 a transverse vertical section of such a converter-box, with the converter in position. The terminals of the primary coil, P, of the converter are led into the compartment, D^1, and the terminals of the secondary coil into the compartment, D^2. The terminals are secured to bolts or couplings, f, f, mounted upon insulating plates, e^1 and e^2. Fusible strips, g, and switch-plates, h and i, with plugs, k, are provided for protecting, and connecting and disconnecting the circuits. The fusible strips and their connected conductors are effectually insulated from each other by a plate of fibre, r^2. The open fronts of the compartments, D^1 and D^2, are closed by glass plates, T, which permit inspection of the connections without entering the box.

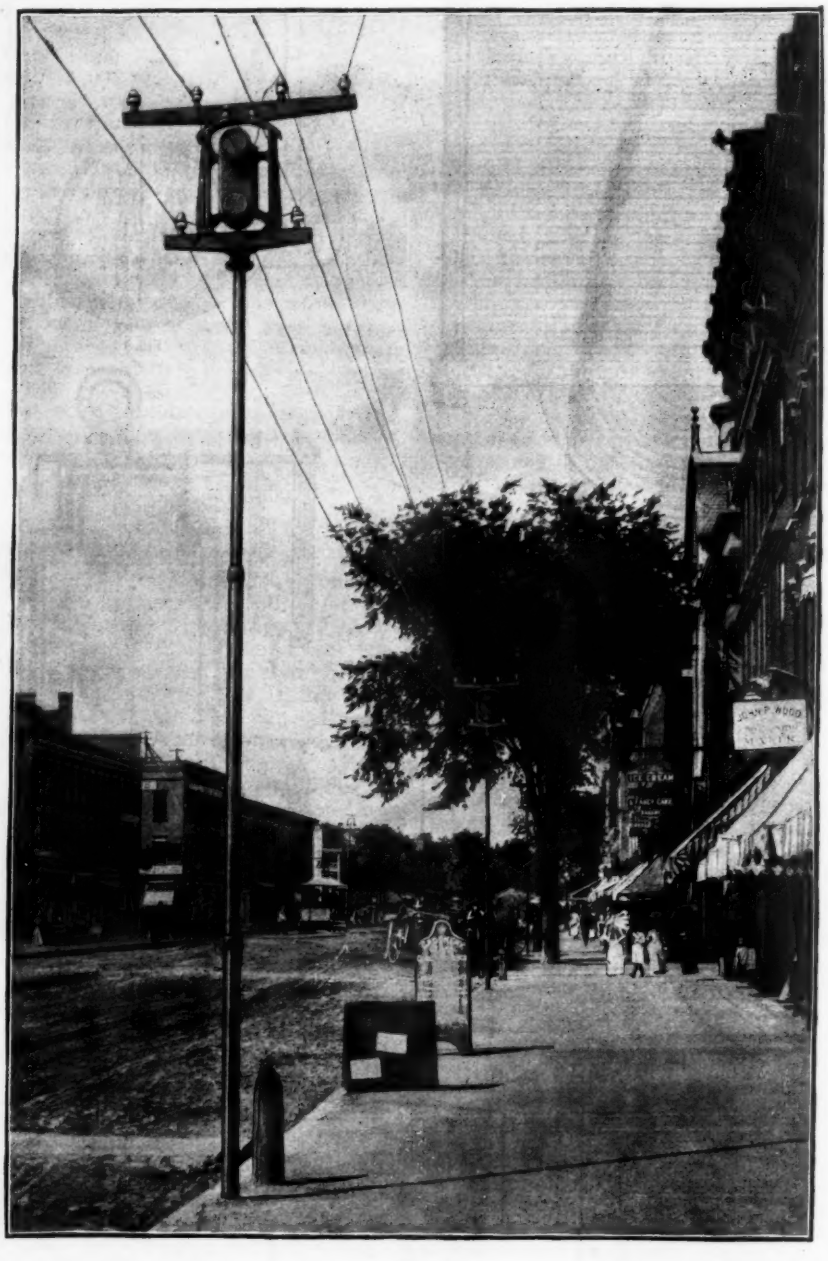


FIG. 13.

The converter-box occupies but little space, and may be placed in any convenient situation in or about the premises to be lighted, much the same as a gas meter. It is usually preferred, where overhead conductors are used, to mount the converter-box upon a pole in the vicinity of the premises to be lighted, as shown in fig. 13, and thus it is only necessary to lead the secondary or low potential wires into the building, the high potential wires remaining in an inaccessible position upon the pole. Fig. 13 is a view in North Street, Pitts-

field, Mass., engraved from a photograph, showing a very neat form of tubular wrought-iron pole with its converter-box, designed by Mr. Stanley, and employed in the installation recently carried out by him in that town. These poles were manufactured by Robbins, Gamwell & Co., a local firm.

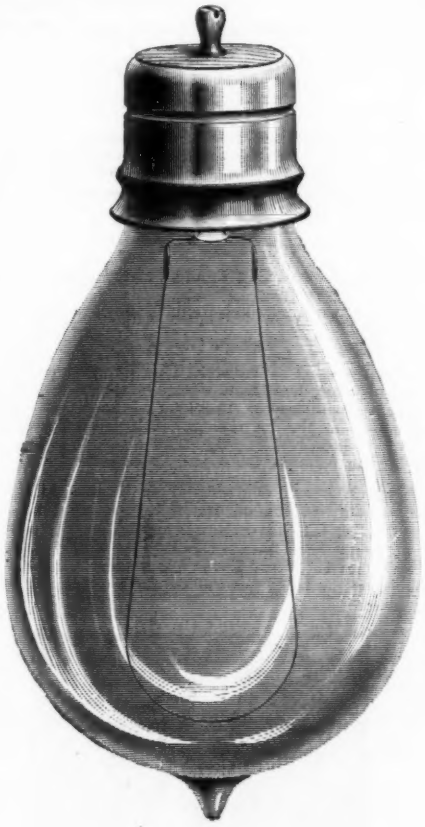


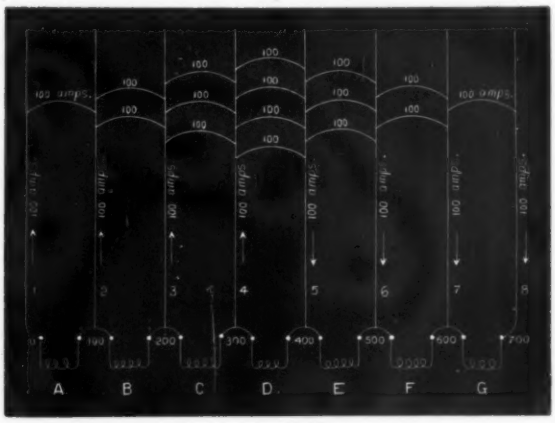
FIG. 14.

The incandescent lamps supplied by the Westinghouse Company are made in four standard sizes, of 16, 25, 50 and 150 C.P. respectively. The greater number of lamps required are, of course, of the 16-C.P. grade, of which fig. 14 is a correct representation in its natural size. The filament is of carbonised silk, a material which has been found to serve the purpose admirably when properly prepared and treated. The fittings of the 16-C.P. lamp are neat in design, ingenious in construction and arrangement, and extremely convenient and efficient in practical use. One of the terminals of the lamp is connected to the insulated brass tip shown in fig. 14, and the other to the thimble or cup of sheet brass into which the neck of the lamp is inserted. The thimble is provided with a semi-circular circumferential groove at the end next the tip of the lamp for a purpose hereafter to be explained.

(To be continued.)

ELECTRICAL DISTRIBUTION.

THE system I am about to describe is designed to combine the advantages of the parallel and series systems. It has all the reliability of the former with some of the economy of the latter. It is supplied with constant potential, and there is a metallic circuit throughout. It is briefly as follows:—Any number of dynamos are joined up in series, and from each junction as well as from the main terminals a main wire is led; these wires being all of equal diameter. Thus in the case of seven dynamos there would be eight mains, each differing in potential from any other by the effective E.M.F. of the dynamo or dynamos between them. Suppose each dynamo to give 100 volts, and each wire capable of carrying 100 ampères, and call the dynamos respectively A, B, C, D, E, F and G, and the wires 1, 2, 3, 4, 5, 6, 7 and 8. Then lamps to the extent of 100 ampères are inserted between 1 and 2 and 7 and 8; 200 ampères between 2 and 3 and 6 and 7; 300 between 3 and 4 and 5 and 6; 400 between 4 and 5, making a total of 1,600 ampères at 100 volts available for lighting. The current carried by each wire is 100 ampères, which is in one direction in 1, 2, 3 and 4, and in the opposite direction in 5, 6, 7 and 8, and the potentials are respectively 0, 100, 200, 300, 400, 500, 600 and 700. With regard to the dynamos, A and G supply 100 ampères each, B and F 200 ampères each, C and E 300 ampères each, and D 400 ampères. It will be seen that the breakage or cutting out of individual lamps will not affect the others, but should a considerable number be cut out of one branch (especially 1, 2 and 7, 8), some of the wires would have to carry more than 100 ampères. Half the lamps between 4 and 5 or 12½ per cent. of the whole installation could, however, be cut out without affecting the other lamps or exceeding 100 ampères in the mains. The choice of seven dynamos and eight wires is quite arbitrary. Had less been taken the economy would have been less, and if more, the economy would have been greater. It must be remembered that as we increase the conductor economy, there is the disadvantage that we have to deal with higher potentials in some of the mains, and that there is a smaller percentage of independent lamps.



One spare dynamo of the same capacity as D would be sufficient, and could be inserted in the place of any heated or faulty dynamo without affecting the lights.

The system would hardly be suitable for domestic lighting because of the great variation in the number of lights used, but would be well suited for lighting hotels, shops, theatres, and other public buildings, especially when the latter are a considerable distance from the source of supply. Though they would generally be so in practice, it is not in the least necessary (except with regard to the spare dynamo) that the dynamos should be of similar voltage. Dynamos F and G, for instance, might well be of 50 to 60 volts each and run arc lamps in parallel (in this case 30 to 35 for the two branches.) As was before remarked, half the lamps between 4 and 5 are perfectly independent, so the whole of this branch (400 ampères) might be safely used for ordinary domestic lighting. The following is a table showing the capacity of the system for different numbers of conductors of 100 ampère carrying power, and also comparing the system with simple parallel at 100 volts, and the series system, the amount of copper in conductors being the same in each case.

No. of Wires.	Capacity in Watts.		
	Parallel.	New System.	Series.
4	20,000	40,000	60,000
5	25,000	60,000	100,000
6	30,000	90,000	150,000
7	35,000	120,000	210,000
8	40,000	160,000	280,000
9	45,000	200,000	360,000
10	50,000	250,000	450,000
11	55,000	300,000	550,000
12	60,000	360,000	660,000

The values for the series system, though correct, are not practicable, since, at the present time, there are no lamps capable of utilising a constant current of from 200 to 600 ampères.

C. G. MCEWEN.

Natal, *September 4th*, 1887.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

(*Specially Reported for the "Electrical Review."*)

MAXIMUM WORK OF AN ALTERNATING E.M.F.

By GISBERT KAPP.

(*Section G.—Mechanical Science.—Monday, September 5th*, 1887.)

THE following investigation applies to all cases where the whole of the work is done in the circuit which receives current from some source of supply having an impressed alternating E.M.F., but it does not apply to those cases where the E.M.F. is impressed on a primary and the work is done in a secondary circuit. As an example, take the case of glow or arc lamps fed in parallel connection direct from two mains between which is maintained an E.M.F. alternating according to a simple sine function. We assume the mean value of this E.M.F. as measured by a Cardew voltmeter or a Thomson electrometer to be maintained constant whatever may be the quantity of current taken by the different lamp circuits, and the periodic time of the wave of impressed E.M.F. to be also constant.

We also assume that each parallel contains a portion having a sensible self induction, and the problem is to find what resistance should be given to the lamp in order to use up or rather transform in it a maximum of energy with the given impressed E.M.F. With a unidirected and constant E.M.F. the lower the resistance the greater would be the energy used up in the lamp; but this is evidently not so in the case of an alternating E.M.F., since upon short circuiting the lamp completely the current does not exceed a certain maximum—which is determined by the self-induction of the circuit—and during a gradual reduction of resistance of the lamp, the current, being one of the factors determining the work, remains therefore finite, whilst the other factor (the E.M.F. over the lamp terminals) approaches zero. A maximum of work can therefore not be obtained by the simple expedient of reducing the resistance of the lamp to its lowest possible value. That an excessive increase of resistance will not accomplish the desired effect is self-evident, and we are thus led to the conclusion that between these extreme values of resistance there must be at least one special value for which the work done in the lamp becomes a maximum. The value of this particular resistance must naturally depend upon the E.M.F. of supply, the periodic time, and the self-induction of the circuit.

Before proceeding further it will be convenient to point out that the same consideration applies to a circuit fed from the secondary coil of a transformer, the primary coil of which is connected in parallel across the mains from an alternate current machine. In this case the E.M.F. appearing on the terminals of the secondary is very nearly constant if the E.M.F. between the mains is kept constant, a condition which must necessarily be fulfilled in a network of mains for public supply of electricity on the parallel system. We may therefore consider the E.M.F. induced in the secondary coil as an E.M.F. impressed upon the terminals of the circuit in which the work is to be done, and thus our problem becomes applicable both to the direct supply and to the supply by means of transformers.

In the diagram let O E = E represent the impressed E.M.F., and O I = I the resultant current, both being maxima, that is the crest of their waves, and let ϕ be the angle of lag. The maximum value of the E.M.F. due to self-induction is then obviously given by the line O E$_i$ = E$_i$, and the maximum of E.M.F. necessary to overcome the inert resistance of the circuit is given by the line O Eρ = Eρ. If r denotes the resistance and L the self-induction, we have Eρ = r I, and E$_i$ = L I $2\pi n$. The angle of lag, as is well known, is determined by the relation

$$t\,y\,\phi = \frac{2\pi n L}{r}.$$

We may now represent the impressed E.M.F. and the resultant current at any moment as the projections of the two lines O E and O I on the vertical, these lines being supposed to revolve round O at a fixed speed, and to always maintain their angular distance ϕ. Let a be their angular advance at the time t, then e = E sin $(a + \phi)$ and i = I sin a represent E.M.F. and current at that particular moment, and

$$d\,W = E\,I \sin(a + \phi) \sin a\, d\, t$$

represents the work done during a further angular advance during time $d\,t$. If T = $\frac{1}{n}$ be the periodic time, $a = 2\pi n t$ and the above equation can also be written as follows:—

$$d\,W = \frac{E\,I}{2\pi n} \sin(a + \phi) \sin a\, d\, a.$$

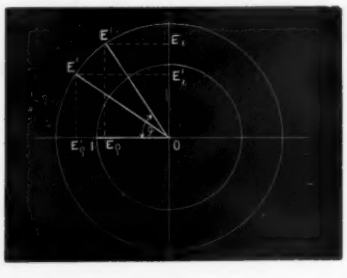
By integrating between the limits a = 0 and $a = 2\pi$, we obtain the work done during the time T (that of a complete period), and by dividing the result by T we obtain the work done in unit time, or the rate of doing work as generally expressed in watts. The operation gives

$$W = \frac{E\,I}{2} \cos\phi \qquad (1)$$

Since the mean value of E.M.F. and current measured by instruments is $\frac{1}{\sqrt{2}}$ of their maxima, we have also

$$w = e\,i \cos\phi,$$

e and i being these mean values. This expression enables us to determine the work done from readings taken with a voltmeter and a current dynamometer, provided we know the resistance of the circuit. From the diagram it will be seen the angle of lag is found by the formula $\cos\phi = \frac{i\,r}{e}$, and substituting we obtain $w = i^2 r$, which is self evident. This result might have been obtained without introducing the E.M.F. at all; but, as will be shown presently, the investigation applies also to cases where, besides an inert resistance, there is a counter E.M.F. in the circuit, and then the term $i^2 r$ is not a correct measure for the work done, and the more general expression given in equation 1 must be used.



From a commercial point of view, it is important that the lag should be small, because the size of the dynamo and mains is governed by the product E I, whilst the work done by the dynamo is governed by the product $\frac{E\,I}{2}\cos\phi$, and it is evident that if ϕ be very nearly 90° we would require an enormously large plant to do comparatively little work. Generally speaking, the size of the plant for a given amount of work will be inversely proportional to cos ϕ. In a continuous current system there is no lag, and the whole volt-ampère capacity of the plant is actually available for useful work; in an alternate current system this capacity becomes reduced in the ratio of 1 : cos ϕ, and cos ϕ might therefore be considered to represent the plant efficiency of the system.

Returning now to the original problem, we have to find the condition under which the work E I cos ϕ, and therefore I cos ϕ, becomes a maximum. From the diagram we see that E$_i$ or $2\pi n$ L I = E sin ϕ, and therefore I cos $\phi = \frac{E}{2\pi n L} \sin\phi \cos\phi$.

To make this a maximum the angle of lag must evidently be 45°. The same result has been found analytically by Mr. Snell, and published in his articles on "Alternating and Induced Electromotive Forces," in the *Electrician* of August 13th, 1886. Graphically, the projections of O E on the horizontal and vertical must have equal length, that is to say, E$_i$ must be equal to Eρ. Maximum work is done in the circuit if the E.M.F. of self-induction equals the E.M.F. necessary to overcome the inert resistance. In this case the following relation must evidently obtain $r = 2\pi n$ L, and by choosing the resistance so as to satisfy this equation we obtain a maximum of work from the given mean E.M.F. e, and in a circuit of given self-induction, L. The E.M.F. which is used to drive the current through this resistance is ·709 of the impressed E.M.F., and this figure represents also the plant efficiency of the system.

The above law of maximum work is capable of application to the case of a series-wound electromotor worked by an alternating current. An ordinary series-wound continuous current motor can be worked by an alternating current if the field is sufficiently

laminated to prevent the formation of eddy currents. There are certain reasons which render it inexpedient and uneconomical to work any apparatus for the utilisation of alternating currents at high degrees of saturation, so that in practice the strength of field of such a motor can be considered as strictly proportional to the current at any moment. In a motor of this kind the flow of current is opposed not only by its inert resistance, but also by the counter E.M.F. developed in the coils of the armature. It is evident that at constant speed of rotation the latter opposing force is proportional to the strength of field, and therefore also to the current, and it is of the same character and period as the E.M.F. necessary to overcome the inert resistance of the circuit. Retaining the above notation, and writing $k\,i$ for the counter E.M.F. of the armature, where k is a coefficient depending on the constructive data of the machine and on its speed, but not on the periodic time and self-induction, we have at any moment $e\,\rho = (r + k)\,i$, and the condition of maximum work is $r + k = 2\,\pi\,n\,\text{L}$. In order that the motor may absorb maximum work, it should be so constructed that the sum of the counter E.M.F. of the armature and the E.M.F. necessary to overcome its inert resistance equals the E.M.F. of self-induction. In order to obtain a high efficiency, r must be small as compared with k, and in this case we may as a rough approximation neglect r, and say that the motor will give out maximum work if its counter E.M.F. equals the E.M.F. of self-induction. This law has a striking resemblance to Jacobi's law of maximum work obtainable from a continuous current motor. There the condition is that the counter E.M.F. should equal the E.M.F. necessary to overcome the inert resistance of the circuit; but whilst in this case the commercial efficiency must be less than 50 per cent. in the alternate current system it may be much more. In so far the alternate current motor would seem to have an advantage over the continuous current motor, but this advantage could scarcely be realised in practice. On the one hand, we never work continuous current motors with maximum output, whilst on the other hand it will be found extremely difficult, not to say impossible, to work a series wound motor by an alternating current of reasonably short period in such way as to satisfy the above conditions for maximum work. It will generally be found that in a motor of this type, owing to the great magnetic inertia of the field, the E.M.F. of self-induction is considerably greater than the counter E.M.F. of the armature, and that to increase the latter without at the same time increasing the former, we should require to run the armature at too high a speed. But even if we cannot completely fulfil the condition of maximum work we can at least attempt to approach it, and the above investigation may serve to show in what direction improvements should be made if we wish to solve the practical problem of obtaining motive power from alternating currents. In experimenting with machines of this class it is, of course, necessary to have some easy means for the determination of the coefficient of self-induction, angle of lag, and plant efficiency. These points can be easily determined by means of the diagram. Two experiments only are required. First, note the mean current and mean terminal pressure when the armature is prevented from revolving; and secondly, note the mean current when the armature is revolving and doing work, the terminal pressure being adjusted to have the same value as formerly. Let, in the diagram, the line O E ρ represent the E.M.F. required to overcome the inert resistance of the motor. This can be calculated from the known resistance and the measured current. By erecting a perpendicular in point, E ρ, and prolonging to the point of intersection with the circle representing the impressed E.M.F., we find the point, E, the angle of lag, ϕ, and the horizontal projection of O E gives O E i the E.M.F. necessary to overcome self-induction. Since the latter is proportional to the current which has been measured, the coefficient of self-induction can now be determined. When the armature revolves the current becomes reduced, and therefore the E.M.F. of self-induction assumes a proportionately reduced value, which in the diagram is represented by the length of the line, O E′ i. To this corresponds the point, E′, on the circle of impressed E.M.F., and projecting this point vertically we find E′ ρ as the E.M.F. necessary to overcome the counter E.M.F. of the armature and the inert resistance of the motor circuit. The latter can be calculated from the current and resistance, and thus the counter E.M.F. of the armature and the electric energy actually available for conversion can be determined.

COMPENSATION OF ELECTRICAL MEASURING INSTRUMENTS FOR TEMPERATURE ERRORS.

By J. SWINBURNE.

(Section A.—Mathematical and Physical Science.)
Wednesday, September 7th.

MOST instruments used for measuring electromotive forces depend on the electromagnetic effect of the current in a coil of high resistance. As the resistance of the coil varies with the temperature errors arise. Thus, a voltmeter wound with copper wire would be quite useless unless a temperature correction were made every time a reading was taken. Prof. Forbes has proposed to put a carbon resistance in series with a voltmeter, as the resistance of carbon falls as the temperature is increased. The idea of utilising this property of carbon is old, but instruments compensated with carbon have not come into use. Unless a carbon were in a vacuum its resistance would no doubt vary, as the carbon would absorb damp and gases.

The temperature error may be caused by the variations of temperature of the atmosphere surrounding the instruments, or by rise of temperature due to the heating of the coils when in use. The method to be described in this paper consists of arrangements of wires of different temperature coefficients, so calculated that the reading of the instrument is not affected by reasonable variations in temperature. The electro-dynamometer wound as a voltmeter is the easiest instrument to compensate. Such an instrument consists of a large fixed coil, or pair of coils, with a small moving coil suspended and connected in series.

If the fixed and moving coils are wound with German silver wire, whose temperature coefficient is 0·044 per cent. per degree C., the readings will vary about 1 per cent. from winter to summer. 0·044 is the coefficient generally given in books, but German silver may have almost any temperature coefficient according to its composition. If an idle coil of copper wire is put in shunt to the moving coil, the current through the fixed coil will be divided between the moving coil and the copper resistance. As the temperature rises the current decreases if the electromotive force is kept constant; but as the resistance of the copper coil increases about ten times as fast as that of the German silver moving coil, the moving coil carries a larger share of the current, and the current in the moving coil can thus be made to increase so that the product of the current in the fixed and moving coils remains constant. Such a system does not give perfect compensation, but the error through ordinary ranges is insignificant. This disposition compensates for the variations of temperature of the room, but not for rise of temperature due to the current itself. In a dynamometer-voltmeter this error is too small to be important, but there is no objection to winding the copper wire round the fixed coil so that it is at the same temperature. It may be doubled on itself so as to have no magnetic effect, or it may be wound backwards; but this gives rise to difficulties in the calculations. It would be of little use to work out examples, as the temperature coefficient of German silver varies with the sample. When the coefficient is known it is generally necessary to solve a cubic equation.

A voltmeter, such as a tangent galvanometer with a controlling magnet, may be compensated for room errors by putting a resistance of copper wire in shunt to it, and a German silver resistance in series; the resistances are so calculated that the current in the galvanometer coil is constant. This arrangement of course wastes a little power, but that is not generally a matter of any importance.

Another arrangement was suggested to the writer by Mr. Evershed, who was working with him. Instead of making the copper an idle coil, it may be wound backwards round the voltmeter, the exterior resistance being dispensed with. The magnetic effect is then the difference of the magnetic effects due to the German silver and copper wires. As the instrument heats the current in the German silver wire decreases, but the current in the copper wire decreases much faster, so that their difference remains practically constant. This arrangement is very suitable for low electromotive force voltmeters, but there are difficulties in the way of its use for high electromotive forces. Unless the copper wire is wound with the German silver, so that the two wires lie side by side, it is difficult or impossible to calculate the effects of the wires. If they are wound together, and the copper wire is then connected backwards, neighbouring wires have the full electromotive force to be measured upon them, and the insulation is apt to break down. In addition to this the copper wire has to be very small. Taking German silver as having ten times the specific resistance of copper by volume and $\frac{1}{10}$th of the temperature error, the ampère turns of copper wire would have to be $\frac{1}{10}$th of the ampère turns of German silver wire, so the diameter would have to be $\frac{1}{10}$th. In most cases this would demand a copper wire of from one to two millimetres diameter, which is too small for practical use.

Most Wheatstone bridges are wound with platinum silver wire, and when exact measurements are required temperature corrections are made. Temperature corrections can be made unnecessary by winding the coils forming the adjustable resistance and the coils of the line side of the bridge with platinum silver, and the coils on the other side of the bridge with wire having twice the temperature coefficient. The coils with double temperature coefficients need not be made of any special alloy, as any temperature coefficient can be got by making the coil partly of platinum silver and partly of copper wire. The bridge still compensates if the galvanometer and battery change places.

The temperature error of a standard cell, such as the Clark, can be compensated. Such cells are arranged in shunt to a resistance which is in series with a larger resistance, which is generally adjustable, and varies from 30 to 60 times the resistance to which the cell is in shunt.

If the adjustable resistances are made of copper and German silver, so as to have higher temperature coefficients than the resistance in shunt to the standard cell, temperature errors of the cell can be eliminated. The adjustable resistance may be made up of ten coils of 1 ohm each and ten of 10 ohms each, 1·438 being in shunt to the cell, and 0·562 between the adjustable resistance and the 1·438 to make the resistance read in round numbers. The ten 10-ohm coils will thus have different proportions of copper and German silver, as their coefficients must be slightly different to compensate throughout the range.

There is another source of error which seems often to escape notice. If an electro-dynamometer is connected up as a watt-meter for measuring small powers, such as that consumed in an incandescent lamp, either the pressure coil is in shunt to the lamp and in series with the current coil, or it is shunt to both the lamp

and the current coil. In one case the current through the pressure coil measures the fall of potential, not only over the lamp but over the current coil also; in the other the current coil measures the current through the pressure coil as well as through the lamp. If all the lamps measured were of the same resistance this would not matter, as the instrument could be calibrated for that resistance, but the error in using the same voltmeter for 50-volt and 100-volt lamps is very considerable.

This error may be eliminated by a sort of differential winding. It is best to fix the current coil and make the pressure coil movable, as there is then less trouble in making the connections. A few turns of small wire, equal in number to those of the current coil, are wound backwards round it and put in series with the pressure coil. The pressure coil is then put in shunt to the lamp only. The portion of the current in the current coil which comes through the pressure coil then has its action neutralised by these backward turns carrying the same current.

The same method may be applied to volt and ammeters when used for such purposes as incandescent lamp measurement. If the voltmeter is in shunt to the lamp only, a few turns in series with it are wound backwards round the ammeter. If the voltmeter is in shunt to the lamp and the ammeter, a few turns of the main or ammeter circuit are wound backwards round the voltmeter coil.

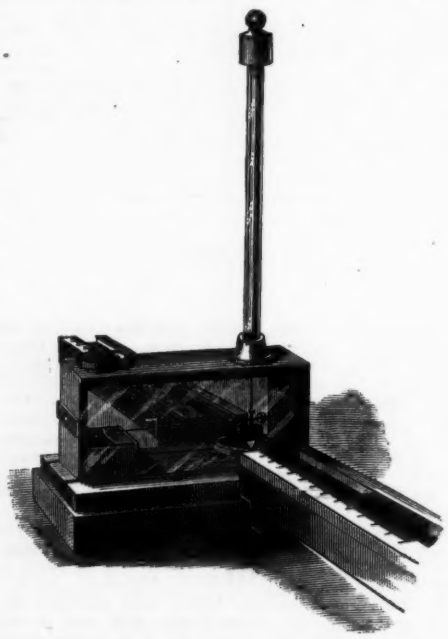
A COMPARISON MAGNETOMETER.

By W. W. HALDANE GEE, B.Sc.

(Section A.—Mathematical and Physical Science.)

Wednesday, September 7th, 1887.

WHEN the moment of a magnet has once been determined in absolute terms, we may use the magnet to ascertain the moment of any other magnet by opposing the two magnets on either side of a magnetic needle, so that the latter is undeflected. For many relative determinations it is not necessary to know the moment of a magnet in absolute terms; any magnet may be taken as a unit. I have designed for the purpose a convenient apparatus



which has been found of considerable use in the Owen's College Physical Laboratory, more especially in investigating the value of magnetic moments produced by different conditions. It consists (see fig.) of a box with glass sides within which is suspended a short magnet provided with a long pointer. The pointer, whose movement is restricted by stops, is suspended above a short scale fixed to a mirror glass. To observe the pointer a window is provided in the roof of the box. Below the magnet is a damper of wire or foil immersed in a glass vessel, containing oil or water. At right angles to the pointer are two millimetre scales of boxwood fixed to two arms screwed to the box. When the instrument is in use the pointer lies in the magnetic meridian, and the magnets under comparison are then placed alongside the boxwood scales. By moving one or other of the magnets the pointer is again brought to its zero position in the meridian. For a first approximation we then have

$$\frac{A}{B} = \frac{a^3}{b^3} \qquad (1)$$

where A and B are the moments of the magnets under comparison and a and b the distances of their centres from that of the suspended magnet. The magnets are then moved to new balancing positions, a_1 and b_1; or

$$\frac{A}{B} = \frac{a_1^3}{b_1^3} \qquad (2)$$

From (1) and (2)

$$\frac{A}{B} = \frac{(a-a_1)^3}{(b-b_1)^3} = \frac{\text{cube of distance, A, is moved}}{\text{cube of distance, B, is moved}} \qquad (3)$$

The method thus becomes one of *differences*, and is independent of the exact value of the distances of the magnets under comparison from the suspended magnet. By making $b-b_1 = 10$ and calling B our unit magnet, all that requires to be done is to cube the distance over which A is moved and make the three last figures decimals. If we wish to introduce a correcting factor for the lengths of the magnets, a table must be drawn up for use with the instrument. However, for magnets not too long and not too weak, the above formula will be found to give quite sufficient accuracy.

As examples of the instructive kind of work for which the instrument is convenient may be cited the following:—(1) For finding the magnetic moment produced by magnetising a steel bar by each successive stroke of a magnet. (2) For testing the effect of dropping a magnet successively from a given height in destroying the magnetic moment. (3) For comparing the different methods of magnetisation. The instrument may also be used for investigating electro-magnetic problems by substituting a magnetising helix for one of the permanent magnets. If, then, bars of different kinds of iron or steel be placed within the helix, their relative values as cores of electro-magnets may be ascertained. These examples will be sufficient to show that the instrument has a wide range of utility.

The instrument is made by Mr. W. Groves, of Bolsover Street, London.

REPORT OF THE COMMITTEE ON STANDARDS OF LIGHT.

(Section A.—Mathematical and Physical Science.)

Wednesday, September 7th.

THE committee has been anxious during the past year to carry out comparative experiments on the various standards of light hitherto proposed, but has been prevented by want of funds from doing much. Prof. W. G. Adams, however, has presented a report to the committee on preliminary experiments made by him, and the committee is fully convinced that if provided with funds they will be able during the next year to complete experiments which will lead to recommendations which, if adopted, would place the question of standards on a satisfactory footing.

ON EXPANSION WITH RISE OF TEMPERATURE IN WIRES UNDER ELONGATING STRESS.

By J. T. BOTTOMLEY, M.A., F.R.S.E., F.C.S.

(Section A.—Mathematical and Physical Science.)

Wednesday, September 7th, 1887.

[ABSTRACT.]

THIS paper gives a preliminary account of experiments undertaken for the purpose of comparing the longitudinal expansion with rise of temperature in wires subjected to different elongating stresses. The investigation has been undertaken partly in connection with the experiments on elasticity of wires, initiated by the British Association in 1876. Copper wires hung side by side in a tube of tin plate about six metres long are alternately heated by steam, and allowed to cool. One of these wires carries one-tenth of its breaking load, the other half of its breaking load. After a preliminary process of hardening the wires, found to be necessary and described in the paper, comparisons were made as to the expansibility with rise of temperature of the heavily-loaded and lightly-loaded wires. The investigation is far from complete, but there seems no doubt that there is a measurable difference between the two expansibilities, that of the heavily-loaded wire being the greater. The experimenting came to an end at the beginning of May, when the supply of steam from the heating apparatus in the Glasgow University Laboratory ceased to be available; but the wires are left hanging, carefully protected, and the investigation will be resumed in October next.

OBITUARY.

CHARLES MOSELEY.

MANY of our readers, to whom the name of Charles Moseley was synonymous with business integrity and sound personal worth, will join with us in expressing deep regret at the sudden and untimely ending of a man whose past has been fruitful of good work, and to whom the future promised even greater prominence than he had already enjoyed. Mr. Moseley had for some time past suffered from occasional acute indisposition. About six weeks ago he made a visit to Nor-

way, and on the return voyage suffered severely from sea sickness. During some 24 hours he refrained from taking food, and it is feared that the paroxysms of sickness which he then suffered aggravated a disease from which it is now known that he must for some time have suffered. A *post-mortem* examination disclosed the fact that death was due to an ulcer which had perforated the stomach. Mr. Moseley was present at the meeting of the Directors of the Manchester Ship Canal on Friday afternoon last, and was observed to leave the room very hastily, and apparently in great pain. He was followed by Mr. Charles Galloway, and they had hardly reached the street before Mr. Moseley fell exhausted into Mr. Galloway's arms. He was carried back into the Ship Canal offices, and medical aid was at once summoned. After an hour or two he was sufficiently recovered to be removed to his home at Grangethorpe, Rusholme, where he lingered in great pain, but with occasional intervals of repose, until his death, which took place shortly after 9 o'clock on Saturday evening.

The firm of D. Moseley and Sons has almost a world-wide reputation. It employs nearly a thousand hands, and has fostered an industry which is all the more remarkable as being entirely unassociated with the staple trade of the district. Originally established by Mr. David Moseley, the business was still in its infancy when his sons Joseph and Charles were introduced into it. While both were still young men the death of their father left them with the responsibilities of the growing business, and by an arrangement agreeable to both, Mr. Charles Moseley devoted himself almost exclusively to the general management of the works, leaving his elder brother to represent the firm on 'Change and elsewhere. As a consequence of this Mr. Charles Moseley was for many years little known to the general public. His life was entirely devoted to the development of the business of the firm. For many years this comparative seclusion continued; and it was not until some eight or nine years ago that his interest in the telephone induced him to step forward into public life. He at one time contemplated establishing a private telephonic exchange in Manchester, but after the amalgamation of the Edison and Bell companies he was induced to accept overtures from the Lancashire and Cheshire Company, which resulted in his appointment as their chairman. How energetically the business has been conducted we need not say; nor is it any disparagement to his co-directors to add that the development of the policy of the company owes much in its initiation to the foresight of its chairman. In nothing was his energy more displayed than in a contest with the Post Office, who strove under the Telegraphs Act to prevent the establishment of telephonic communication between adjoining towns. Mr. Moseley put himself in correspondence with the various Parliamentary representatives of his district, and so convincing were his arguments that from time to time questions were asked in the House which Mr. Fawcett had great difficulty in answering. Subsequently Mr. Moseley had frequent interviews with the Postmaster-General, and it is not too much to say that he succeeded in converting him almost entirely to his views. As a result the present "trunk-line" system has been developed, by which it is possible for most of the Lancashire towns to hold telephonic communication with each other. During the period that this matter was before Parliament, Mr. Moseley not infrequently left Manchester after a day's labour at his works, was in the lobby of the House of Commons interviewing Members towards midnight, returning to Manchester an hour or two later for the duties of the following day. Such extraordinary energy could not but attract the attention of all who were cognisant of it, and from that time Mr. Charles Moseley has been one of the most noticeable persons connected with Manchester life. When the Edison Electric Light Company was formed, his interest in electricity induced him to take a leading position, and as a director he has never ceased to attend assiduously to its welfare. When the fortunes of the Ship Canal seemed at their lowest, he was one of those who consented to form a Consultative Committee to consider and report upon the merits of the scheme. Like some others of the Consultative Committee, he entered on the inquiry, if not in a hostile spirit, at any rate in a spirit of incredulity as to the possible success of the undertaking. As is now generally known, he and his colleagues on the committee were absolutely converted by the evidence which was laid before them. Hardly had Mr. Moseley entered on the arduous duties connected with the promotion of the Ship Canal before he was called upon to take a leading part in arranging for the Jubilee Exhibition. The energy and experience which he brought to bear at the meetings of the Executive Committee, and above all at those of the Committee of No. 7 Section, of which he was chairman, are known to all who were brought in contact with him. No. 7 Section has charge of the electric lighting of the building and of the gardens, of the music, and of the catering. The lavish expenditure on the lighting and music would hardly have been ventured on but for the confidence the Committee felt in the good sense, admirable judgment, and exceptional experience of Mr. Moseley.

Amongst other numerous enterprises with which Mr. Moseley was associated, was the establishment of our esteemed contemporary *Industries*, and nowhere was his characteristic thoroughness more notably displayed than in the conduct of that excellent journal. The project was a bold one, but Mr. Moseley was possessed of both confidence and patience. *Industries* has created a place and a reputation for itself, and we are prepared to see it become, with continuance of the initial energy of direction, one of the most successful periodicals of its kind.

Mr. Moseley was in his 48th year. His funeral took place on Wednesday morning at the Southern Cemetery, and was attended by a numerous gathering of relatives, friends, acquaintances, and workpeople.

NOTES.

Water Power for Electric Lighting.—The contract has been let by the Edison Sault Ste. Marie Power and Light Company for the building of a water-power canal along the rapids of the St. Mary's River. The canal will be about 2,000 feet long and 50 feet wide; it will be widened as the demand shall require. The power from this canal will be used to propel the street cars and run elevators, printing presses, electric lights, &c.

Electric Lighting in Germany.—The number of electric installations in 13 large towns of Germany has risen during the last two years, according to Dr. Schilling, from 131 to 604; the number of arc lamps from 591 to 3,280; the number of incandescent lamps from 10,403 to 50,469. The number of gas burners in these towns is 1,221,882. Electricity therefore provides 4 per cent. of the lighting. The greatest actual number of electric lights is in Berlin; but the greatest proportion is at Munich, where it amounts to 8 per cent.

Progress of Gas and Electric Lighting.—Prof. Hartmann, of Berlin, read a paper at the Hygienic Congress at Vienna on "The Progress of Gas and Electric Lighting," in which he came to the conclusion that, owing to recent improvements, both means of illumination were equivalent from a hygienic point of view—an opinion which was, however, not shared by the majority of members taking part in the discussion.

Bank of England Lighting.—We are glad to hear that the authorities have determined to extend the electric light to most of the leading offices in the Bank,

and the plant is now being put down for about 500 lights. The installation is in the hands of Messrs. Drake & Gorham.

Electric Lighting in Theatres.—The managers of Berlin theatres learned early to appreciate the safety of electric lighting, and consequently this method of illumination is here (says the Berlin correspondent of *Industries*) rather the rule than the exception. The installation in the Opéra is now complete and contains 5,000 lamps, whilst the Royal Theatre contains 2,000 lamps, and both are fed from the electric light station in the Markgrafenstrasse. In the so-called "German Theatre" the electric light installation has been increased, and now contains 1,200 lamps, fed by a double set of dynamos and steam engines. The engines have been made by Borsig, whilst the dynamos and cables have been supplied by Messrs. Siemens and Halske. A very perfect system of switches and regulating appliances is now in use at the theatre. The stage regulator, by which the scenic effects are produced, is the invention of Herr Hugo Bähr, of Dresden. The rheostats employed are similar to those originally used in physical laboratories, but on a much larger scale. The German silver wire is wound upon a spiral groove in a glass cylinder, and by turning the latter more or less resistance is inserted. Colour effects are produced by green and red glow-lamps, and the rheostats not only serve to regulate the power of the light, but also to pass from one colour to the other. Two other theatres are now being fitted with the electric light, the Friedrich-Wilhelm Theatre, and that known under the name of the "Residenz Theatre," whilst a smaller place of entertainment known as the "Reichshallen Theatre" was provided with electric light some time ago. I learn on good authority that the Town Council intend to light the principal street of Berlin, Unter den Linden, with 120 arc lights.

Electric Lighting in Spain.—Tenders are invited for lighting the town of Palencia with the electric light. The local authorities have laid down no fixed conditions to be observed. At present the town spends £520 annually on public lighting.

Humming of Telephone Wires.—Writing to the *Times*, Mr. John Shakespear says:—"The humming of the out-of-door wires of the telephone is at times very annoying. However, I have discovered an exceedingly inexpensive and simple remedy which any one can apply. Pass the wire through about six inches of loosely-fitting India-rubber tubing, which fasten near the post or terminal with string or wire; or twist thick string loose round the wire near the post, the effect will be practically the same. The accompanying two samples of tubing which I use are 3-16in. and $\frac{1}{8}$in. internal diameter, and will explain the subject."

Telephone Wires in Dorchester.—In referring to the dispute between the Western Counties Telephone Company and the Dorchester Town Council last week we said that Mr. Lewis, general manager and secretary of the Telephone Company, relied upon the report of the Parliamentary Committee of 1885, whose recommendations, as we stated, were unfortunately not adopted. This is not precisely correct, or, if correct, is not the whole truth. Mr. Lewis drew the attention of the Council to the report, in which it is shown that local authorities have no rights enabling them to interfere with wires crossing roads and streets, except so far as may be necessary for the maintenance of the highway free from obstruction and danger. In fact, Mr. Lewis relied upon the facts given in evidence before the Committee, and not merely upon the report which the Committee presented. The main "fact," of course, was the decision of the Court of Appeal in the Wandsworth case.

The Brighton Telephone Exchange.—This exchange, which has been established by the South of England Telephone Company, is now in full working order, communication having been established between the Town Hall, railway, fire brigade, and police stations, hospital, theatre, and various other public institutions.

Grievances of the Telegraphists.—The male staff (established) of the London Central Telegraph Office, having drawn the Postmaster-General's attention to the grave disadvantages under which they labour, as compared with clerks in other branches of the Post Office, and also to the increasingly harassing nature of the duties performed by them, with such complete satisfaction to the Department and to the public, and having petitioned him that the vexed questions of salaries, sick pay, Bank Holidays, and hours of duty, which have so long agitated the staff, should be settled once for all, upon a scheme more in accord with the other departments of the service, have received the following reply from the right hon. gentleman:—"The Postmaster-General much regrets that it should be necessary for him to give an unfavourable reply to the petition of so deserving a body of officers as the male telegraphists of the Central Telegraph Office. It is impossible for the Postmaster-General to admit the justice of an application which is based on a comparison of the position of the telegraphists with that of other officers in the service, who entered under different conditions, and who passed a competitive examination of a much more difficult nature. Clerkships in the Savings Bank, and in other branches of the General Post Office, have for a long time been thrown open to general competition; and as regards a large proportion of the telegraphists at present employed in the Central Telegraph Office, the obvious question which arises on the statements of the petition is, why these officers did not avail themselves of the opportunity of passing that examination. As regards the others, it is, he thinks, not to be disputed that their pay and prospects are better in the service of the Department than those which they could have hoped to attain in the service of the companies. As to the relative nature of the duties, those performed by the telegraphists are not to be measured by the same standard as those performed by clerks in the Savings Bank and other Departments of the Post Office. On the question of the performance of a week's duty of 10 hours per day, followed by a week's duty of six hours per day, the Controller shall be requested to consider whether it is possible to rearrange the duties in a manner more agreeable to the telegraph staff, if this can be done with a due regard to economy; but the Postmaster-General regrets that he does not see his way to reduce the average daily attendance from eight to seven hours." In consequence of the unsatisfactory nature of the Postmaster-General's reply, and the fact that several questions mentioned by the signatories in their petition still remain unanswered, it is contemplated to hold a general meeting of the male staff at an early date.

American Telegraphs.—A *Times* telegram from Philadelphia on Tuesday said:—"Confident statements are made to-day that the Baltimore and Ohio Telegraph Company will pass under the control of the Western Union Telegraph, and that the arrangements are already made, but they await Mr. Robert Garrett's return for promulgation. This report has strengthened the stocks, but they weakened at the close."

Removal.—The offices of Messrs. Howard and Haig, electrical engineers, have been removed from 41, Finsbury Pavement, to 11, Charterhouse Buildings, Bishopsgate Street, E.C.

Electrical Literature.—Messrs. Longman will shortly publish the following books:—"Electricity and Magnetism," by T. P. Treglohan; "A Course of Lectures on Electricity," by Prof. Geo. Forbes; and "Sound, Light, and Heat," by M. R. Wright.

An Electric Microscope.—At the Hygienic Congress, whose meetings were held at Vienna last week, great interest was shown in an electric microscope, which Dr. Stricker, Lecturer on Experimental Pathology at the Vienna University, demonstrated to about 350 foreign members. The advantage of this microscope is that it is possible to use the best high power lenses with a linear magnifying power of 4,000.

The Pyromagnetic Generator.—Writing to the New York *Electrical Review*, Mr. Wm. B. Cooper, of Philadelphia, says :—"I spent several years endeavouring to produce a practicable motor operating by the remarkable change of iron at a red heat, and brought the results of my investigations and my experimental apparatus before the Committee of Science and Arts of the Franklin Institute in the winter of 1884–5 for an advisory report. The plan I proposed was the same as that adopted by Mr. Edison, namely, using laminated armatures, and alternately heating and cooling them above and below the critical temperature at which the magnetic change occurs. I filed an application for a patent in the year 1884, but was much discouraged by the fact that at the high temperature oxidation of the heated iron would occur, notwithstanding a coat of plating or enamel. The idea of producing electricity upon this plan also presented itself to me ; but as the same difficulty would have to be overcome, I considered it impracticable. I have, however, recently devised a plan for heating and cooling which prevents oxidation, and is applicable to a generator ; and I am preparing an application for letters patent in which I will incorporate a certain feature of my motor, which I believe was original with me. My investigations of the records brought to light an experiment of Prof. Gore, described in *Philosophical Magazine*, Vol. 40, p. 173, 1870, in which a rod of iron having a coil at each end, one being connected with a battery and the other with a galvanometer, generated induced currents when the central portion of the rod between the coils was heated and cooled. It is true that he was examining the magnetic change in iron, and not endeavouring to produce a generator of electricity ; but his apparatus was a generator as truly as Faraday's wire moving across the lines of force was a dynamo."

The American Institute Electrical Exhibition.—The Electrical Exhibition at New York was opened on Wednesday last week. A number of exhibits of a novel character have been recently added, among them an electric launch and an arc lamp of decidedly new construction. One of the most interesting features will no doubt be the historical exhibit to be made by the New York Electrical Society, the Electrical Section of the American Institute. Early work in the telegraph and telephone will be well illustrated by a large number of models lent by private individuals, and through the courtesy of a number of scientific institutions the collection will be enriched by apparatus unique in its character. The Franklin Institute, of Pennsylvania, has lent Franklin's original frictional machine ; the original Saxton magneto machine ; the original Morse telegraph message ; Bain's original chemical telegraph instrument ; Dr. Hare's lightning rod ; a section of the first Dover-Calais cable, together with other apparatus of an interesting nature. The Stevens Institute of Technology will also contribute its historical electric apparatus to the exhibition. These exhibits, side by side with the most modern improvements in telegraphy, ocean cabling, electric light and motors, will make a striking contrast and a valuable demonstration of progress.

Melting Copper Wire.—A correspondent writes :—"I should be very much obliged to any one of your numerous readers who could give me the necessary ampères to melt a No. 40 B.W.G. bare copper wire. A table giving the ampères required to melt the following besides would be very acceptable, Nos. 38, 36, 34, 32 and 30 B.W.G. I lack the necessary instruments, &c., to carry out the experiments myself, otherwise I should not trouble you ?

Personal.—Mr. Guy C. Fricker, who was lately with the Gülcher Company, has taken offices at 12, Delahay Street, Great George Street, Westminster, where he has started in business as a consulting electrical engineer.

Adelaide Jubilee Exhibition.—In the Victorian Court at the Adelaide Exhibition, the India-rubber, Gutta-percha, and Telegraph Works Company, which has established a branch at Melbourne, has a handsome display of its special manufactures. Mr. James Farrand is the agent in charge.

Royal Jubilee Exhibition, Manchester.—Amongst the many industries which claim attention at the Royal Jubilee Exhibition, that of electric lighting attracts marked attention. It is in itself a combination of industries and comprises important manufactures. Chief amongst these is that of the electrical "conductor." The importance of this branch is very graphically illustrated by a column of copper 10 feet high by 2 feet square, which may be seen in the centre of the dynamo room, a very conspicuous object. This column represents the quantity of copper used for the main conductors utilised for the incandescent lighting of the exhibition. The total quantity of highly insulated cables manufactured and supplied for this purpose by Messrs. Walter T. Glover & Co., of Salford, Manchester, is over 9 miles, and the gross weight of copper alone represented by the column is 10 tons. The square column or trophy is a novel and very interesting exhibit of a most important branch of manufacture.

Collisions at Sea.—We have received an interesting publication by Mr. Somzée, a well-known Belgian engineer, relative to a method devised by him for preventing collisions at sea. The system consists generally of a method of communicating between ships, or between ships and the shore, by telegraphic means. The general principle of the idea is the well known method of telegraphing across rivers or sea estuaries without wires, large conducting plates being placed opposite each other on either bank of the river or estuary. Mr. Somzée has for many years been working at the problem, and he claims to have now developed the points of detail necessary to make the system a complete and successful one. Personally, we have very grave doubts as to the practicability of the idea, even in its very simplest form.

The Watt Dynamo.—Mr. Hugh Watt, M.P., chairman of the Maxim-Weston Company, has designed a dynamo for which he claims, that while it is one of the most compact and simple of machines and calculated to prove even more durable than others, it can be produced at a price certainly 50 per cent. lower than any other dynamo giving the same results. It has only one field, the position of which in relation to the armature, is such that a machine of this construction now being shown at the works of the company which is said to be capable of feeding 160 lamps of 16 candle-power, occupies a space of only 3 feet × 2 feet × 1 foot 6 inches. The frame and parts of the machine are constructed of gun metal, and it is considered that with ordinary care the only expense for renewals would be in the way of new brushes.

Jensen Bells at the American Exhibition.—The Director-General of the American Exhibition has addressed a letter to the Jensen Electric Bell and Signal Company testifying to the usefulness and accuracy of the electric bells and clocks supplied to the Exhibition, and stating that he is not aware of a single case of either failure or inaccuracy during the four months they have been at work.

Fire Alarm Tenders.—The guardians of the Bristol Incorporation invite tenders for the supply of electric fire-alarm bells, with the necessary apparatus and fixing the same, at their workhouse at Stapleton. Tenders should be sent to Mr. J. J. Simpson, clerk, St. Peter's Hospital, Bristol, by 12 noon on the 20th inst.

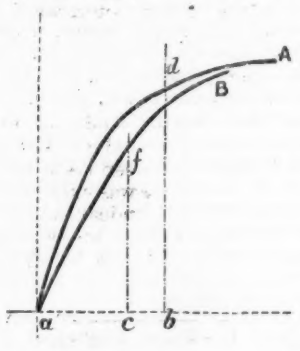
A Sign of the Times.—At the last meeting of the Plymouth Town Council it was resolved to accept the tender of the local Gas Company for the supply of gas for public purposes for seven years at a cost per lamp of £3 7s. 6d. An opinion was, however, generally expressed that the period of seven years was much too long, inasmuch as it might be desirable to adopt the electric light before the expiration of the contract, and the recommendation was only agreed to on its being stated that the company would not agree to any other terms.

Electricity in the Royal Navy.—As a result of a series of experiments which were recently carried out on board men of war at Portsmouth, it has been decided to fit all the large vessels belonging to the Royal Navy with electric telegraphs and indicators, so as to facilitate communication between the deck and engine rooms. The mechanical communicators, which were considered to be inadequate owing to the noise of the machinery and other causes, are to be retained in case of a telegraphic breakdown.

Medical Use of Electricity.—A striking illustration of the advantages which may attend the use of electric currents for medical purposes is furnished by the case of John Windeatt, who has just derived great benefit from the treatment of Mr. W. Lynd. Windeatt had suffered greatly from a swelling of the left knee for four months, and had tried without avail various well-advertised "remedies." Carefully measured currents, continuous and alternating, were applied on September 10th, and two days later the patient was able to report that he had for the first time for ten weeks enjoyed rest at night and comparative comfort by day. Repetitions of the electrical treatment caused diminution in the size of the knee, and on the 16th of the month the patient, who was highly delighted by the change, was able to bend his limb without difficulty, and the knee is now just half the size it was when first subjected to the action of the current.

Electric Lighting in South America.—We believe in the wisdom of listening to the arguments of an opponent, and whilst the *Gas World* is not necessarily an adversary to electric light men, they may yet benefit somewhat by giving heed to what it says. Speaking of the triumph with which America is pointed to as an illustration of what the electric light may do, our esteemed contemporary says: "Even in America electric lighting companies are not getting it all their own way. We hear of one city in the South, which has been hitherto destitute of that evidence of civilisation—a gasworks—but in which the deficiency is at length to be supplied. We refer to La Plata, a thriving city of 50,000 inhabitants. Electricity has been the artificial illuminant chiefly employed in that city, but it has proved so unsatisfactory and troublesome that a change is to be made to gas. A native company has been formed, and works capable of producing 100,000,000 cubic feet are in course of construction. The fact that such a, comparatively speaking, modern city is going to abandon the electric light will be a bitter pill for enthusiastic electric lighters to swallow. At Monte Video the public lighting by the gas company was some time ago threatened by an electric enterprise. But the gas company took time by the forelock, and ordered a number of powerful gas lamps, ranging up to 800 candles each, and erected them at points of advantage before the electricians were in a position to make their display. Complaints have been freely made that this action on the part of the gas company was unfair. No doubt it is unfortunate—for the electric light—but where the unfairness comes in we are at a loss to see. The proprietors of the electric light may be chagrined that the gas company declined to allow its territory to be carried by storm without making any defence. But, on the other hand, disinterested observers will not fail to perceive that the directors of the gas company owed the duty to the shareholders to preserve their property and business, and this they have done. The Monte Video incident is but another illustration that when gas lighting is vigorously and scientifically carried out, the electric light, in any form that has yet been brought out, has no chance of success, so far as street illumination is concerned. A main reason for this is that gas lights are of the power they are said to be, whereas electric lights are not. Put a real, say, 200-candle gas lamp in comparison with a nominal 2,000-candle electric lamp, and the former will hold its own. That fact has been repeatedly proved, and electricians are fully aware of it."

The Magnetic Circuit.—Writing to *Industries* upon a subject which was discussed in Section A of the British Association's Meeting, Mr. W. B. Esson says:—"From the fact that no time was left at the B. A. meeting for the proper discussion of the papers relating to dynamo construction, it is to be feared that much has been lost which, in the way of practical suggestion, might have proved useful. A point which I think worthy of notice occurred to me during the discussion on Prof. Ewing's paper concerning the "Influence of Transverse Section on the Magnetic Permeability of Iron," but time prohibited any reference to it in my remarks. Prof. Ewing exhibited in a series of curves the effect produced by increasing the number of joints, or, what is the same thing, the air spaces in the magnetic circuit, and the figure here drawn may be taken



to represent the curves of magnetisation under the conditions of a greater (B) and lesser (A) air resistance. Exciting currents are represented by abscissæ and intensity of field by ordinates. Most dynamo makers know generally the effect of putting plates of non-magnetic material between the joints of the magnets, but few may be aware that a dynamo in some respects faulty may be made to work well by so doing. In a machine compounded for constant potential, it sometimes happens that the characteristic falls, instead of rising, as it should, towards full load, the reason being that the magnets are saturated by the shunt coil to a degree which prohibits the series coil from adding the necessary E.M.F. to the circuit. In such a machine let A be the curve of magnetisation, *a b* the excitement furnished by the shunt coil, and *d* the point from which the series coil begins to act. If we increase the air space the strength of field will be diminished to a point *f* on a new curve of magnetisation, and the E.M.F. to a corresponding degree, the exciting current being now equal to *a c*. But it will be observed that in addition to weakening the power of the shunt by increasing the resistance, we have increased the power of the series, the latter now beginning to act at a point where the curve is much steeper. We thus see that by augmenting the air space, and so increasing the magnetic resistance, the fault of the falling characteristic in a compound machine may be cured, and it might frequently be easier to adopt this method than to rewind the magnet coils. In actual practice thin plates of brass or zinc might be inserted between the magnet joints. To get the original E.M.F. the machine will have to run somewhat faster than before, but the compounding will be quite satisfactory.

Electric Motors and Printing Presses.—For running printing presses electric motors are already in great favour, and are now used in a number of newspaper offices. The Detroit *Daily Tribune* is regularly printed by electric motor power, and motors may be found in the offices of the Lowell *Daily News* and *Daily Courier*, the Lawrence, Mass., *American*, the Elgin, Ill., *News*, and the local papers at Abilene and Hutchinson, Kan., and elsewhere.

The Field Electric Motor.—The Field motor was given a trial trip on the Thirty-fourth Street Branch of the New York elevated road about a week ago. The motor easily accomplished all that was required of it, the test proving entirely satisfactory to the inventor, who is said to be a most severe critic. The Field motor has been exhaustively described and illustrated in the REVIEW, and is therefore familiar to our readers. Its adoption by the entire elevated system is anticipated.

Secondary Battery Traction.—"Prof." Reckenzaun is still busily engaged in demonstrating, with the assistance of Mr. W. Wharton, of the Wharton Switch Company, and Mr. G. H. Condict, the advantages of electric locomotion on street railways by means of secondary batteries. On September 22nd Mr. Geo. W. Pearson, president of the Metropolitan Street Railroad Company, of the City of Washington, and several of his directors, visited Mr. Wharton's works and took a trial trip on an electric car through the streets of Philadelphia. All the tests that were suggested by the passengers were made, and in every instance the motor was said to be perfection itself. Stopping on steep grades and in the middle of very short curves was done instantly, and when the signal was given the car started just as easily as though there were no such things in existence as grades or curves. After luncheon Mr. Wharton spoke eloquently of the electric car, its inception and growth, and gave particulars of the comparative cost of electric cable, and horse cars, declaring the first-named to be faster, cheaper, and more satisfactory than any of the others. Mr. Wharton then introduced Mr. Reckenzaun as "the greatest authority in the world upon motors driven by stored electricity." In commending electricity for street locomotion to his hearers, Mr. Reckenzaun said that some critics said the battery employed was two heavy—it being 3,200 lbs. in weight—and proved theoretically to their own satisfaction that it could not generate enough power to drive itself, much less propel the car and passengers. Figures were given showing the fallacy of such an argument, which of course had already been answered by the practical run. Mr. Reckenzaun touched briefly on the renewal of battery plates, and said they would last at least a year, and could then be renewed without much waste. "If the plates last but three months," said he, "they would still be cheaper than horse-flesh." Mr. Wharton said the company proposed to put their cars and motors on the streets of any city at their own expense, and if they did not do all that was claimed for them then the company would remove them. President Pearson expressed himself as fully satisfied with the motor. "Every promise made as to its capabilities," said he, "has been fulfilled, and I believe it is but a question of time—probably not long—when it will be introduced in Washington." The delegation was both surprised and delighted at the success of the motor, and it was regarded as more than probable that inside of the next two months at least one of them would be in working operation on the line of the Metropolitan railroad.

An Enterprising Journal.—We are pleased to be able to congratulate the *Western Electrician*, of Chicago, on its survival through its first quarter. During the 13 weeks of the paper's existence it has not issued less than a total of 24 pages in any number, and it has issued as many as 38 pages in one number. This record, it boasts, has never been excelled by any weekly electrical paper, young or old, save in a single instance; in the case of a bantling of 13 weeks it may be regarded as well-nigh phenomenal.

National Company for the Distribution of Electricity by Secondary Generators.—We understand that this company, which employs the Gaulard and Gibbs system, has concluded arrangements with Messrs. Elwell-Parker, Limited, of Wolverhampton, for the manufacture of its apparatus, and that it has, in consequence, closed its works in Castle Street. We are also informed that the late Mr. Charles Moseley, whose sudden death we record this week, had arranged to join the board of the National Company.

Electric Lighting in Belgium.—*Industries* states that the large shop of M. Hirsch, of Brussels, is to be lighted electrically, 300 Swan glow lamps and 40 Piette & Krizik arc lamps of 600 to 1,000 C.P. being used. The steam engine, which is of 80 H.P., and a multitubular boiler, are placed in a separate building about 55 yards distant. Two Schuckert dynamos will be employed.—The electric light will take the place of gas in the flour mill of M. Dambot, in the central district. There will be about 50 incandescent lamps of 16 C.P. and an arc light of 800 C.P. A dynamo of 80 volts and 65 ampères will be used, the necessary power being derived from the existing steam engine.—Among other electric works in progress are installations at the sugar works of Messrs. Mellaerts, at Saint Trond, and at the spinning mill of Messrs. Oudin & Co., at Dinant.—The following tenders have been received for the installation at the new military hospital at Brussels: The Société Electricité et Hydraulique, of Charleroi, £2,688; Bouckert & Cie, of Brussels, £2,724; the Société Phœnix-Edison, of Ghent, £2,733; the Société Industrielle de l'Electricité, of Brussels, £2,924; and the Société l'Electrique, of Brussels, £2,964.

The Magnet in Paper Manufacture.—Manufacturers of paper and printers often suffer considerable loss from the fact that the dampening of the paper brings out little specks of iron rust which stain the paper. The iron gets into the paper by abrasion of the machinery used in its manufacture. It is well known that magnets will often remove particles of iron from substances containing them. The *Papier Zeitung* announces the adoption of the principle in the manufacture of paper. Magnets are arranged in the form of a comb, being fastened, as shown in the figure, to a strip of hard rubber by brass plates, the whole mounted on a wooden support. The magnets are hung across the stream of pulp and water, dipping well into it, so that it has to pass through the comb. The result is very satisfactory, and all floating iron particles are removed.

Electrification of Air.—R. Nahrwoldt has made a series of experiments on the gradual loss of electricity of electrified bodies. In an essay published in 1878 the author proved that the discharge takes place by means of the particles of dust suspended in the air. These are electrified and then repelled from the electrifying body. The result of these experiments led Lodge and Von Obermayer to their method of clearing rooms from smoke. Later on, it was shown that a wire of platina made red-hot by electricity electrified the surrounding air, although it was almost free of dust. For this reason Nahrwoldt resumed his experiments. He found that electricity was discharged through a point only in dusty air. He made his experiments in an air-tight glass shade, the sides of which were covered with a thin layer of glycerine. After the dust was precipitated on the sides of the glass through the action of the electricity, the discharge was very slight. As soon as a wire of platina was electrified, and became red-hot, electricity was again discharged through the point. Nahrwoldt concluded that this was due to particles flying from the red-hot wire. This conclusion was proved to be correct by the occurrence of platina in the deposits on the sides, and by the loss of weight of the wire. These experiments led him to the conclusion that air free of dust cannot be electrified statically.

To Correspondents.—We are under the necessity of once more reminding our correspondents that we cannot insert letters received on Thursdays in the same week's issue. We have this week received several communications which we should have liked to insert, but which we were compelled to omit by reason of their late arrival.

NEW COMPANY REGISTERED.

Electric Car and Power Company, Limited.—Capital £100,000 in £1 shares. Objects:—To purchase the letters patent, No. 2,783, dated 26th February, 1886, granted to Alfred James Jarman for improvements in the construction of electro-motors for the propulsion of tramcars, electric locomotives, vehicles, and other purposes. To acquire any improvements on the said invention and any extension of the patent rights, and to carry on business as electricians, electrical and mechanical engineers. Signatories (with 1 share each):—Alfred James Jarman, electrical engineer, 82, Willett Road, Brixton; C. J. B. Reed, Holland House, Highbury New Park, N.; T. H. Church, Winchester House, Old Broad Street; T. Twinch, 83, Devonport Road, W.; R. Sindall, Catford, S.E.; C. E. M. Barker, Harold Wood, Essex; P. Dobson, 68, Mervan Road, Brixton. The signatories are to appoint the first directors; qualification, £250 in shares or stock; remuneration, chairman, £200 per annum, and each director £100 per annum, to be doubled when 10 per cent. dividend is paid. Mr. A. J. Jarman is appointed general manager of the company's works for seven years. Registered 29th ult. by Burn & Galloway, 50, Gresham Street.

CITY NOTES, REPORTS, MEETINGS, &c.

The Direct Spanish Telegraph Company, Limited.

THE twenty-eighth ordinary general meeting of the shareholders of this company was held on Friday, the 30th ult., at Winchester House, Old Broad Street, Sir James Anderson, chairman of the company, presiding.

Mr. Charles Gerhardi, Secretary, having read the notice convening the meeting,

The Chairman said: You will remember that we promised when the new scheme for the readjustment of our capital was carried out, that we would probably give you a dividend of 2 per cent. The report will show you that we are now in a position to declare a dividend at the rate of 2½ per cent. In the remarks I made at the last meeting I notice I held out the prospect that there might be 4 per cent. for the year, and had the traffic continued throughout as it was then we should inevitably have given you 4 per cent., but immediately after our meeting we came upon what we call a bad half-year, and the traffic went down, and continued low until about three months ago. I still hope as that was our bad half-year and this is now our good one—and we have already earned upwards of £670 more for the three months of this half-year than we did for the corresponding period of last year at a higher tariff—that we may partly redeem our promise. We are working, as you know, at a reduced tariff, and it will interest you to know that to earn the £367 referred to in paragraph 2 of the report we have had to carry 180,000 words in excess of what we carried in the previous half-year, and the expense of earning that £367 over that of the previous half-year was £72. This half-year we are, for the three months that have gone by, £670 to the good, and I look forward, when we next meet you, to declaring a dividend that will make up at least 3 per cent. for the year. This is all we know and all we can know. It is true that the dividend is a very modest one—too modest for a submarine telegraph property. I have before remarked at these meetings, I think, that any telegraph company that can earn a dividend when forced down to a minimum tariff—that is, a tariff below which we hardly look to be forced hereafter, or, at any rate, for a very long time—any telegraph company that can pay a small dividend at such a low tariff is to be congratulated, because I think the days have gone by for high tariffs. The Press, different Governments, and rival companies are all forcing us down, and are determined that we shall not, if possible, make a living. Therefore, to get to a dividend-earning position at a tariff so much reduced is to my mind not altogether unsatisfactory. Besides, in this Direct Spanish Company we have the elements of life and growth. All the growth we have had this half-year since we became a living concern has been due to commerce. No king has died, no prince has been born, and no political complication has arisen to make our revenue greater than it would be under normal conditions. It seems to us, as far as we can examine it, to be a fair development of commercial trade. I therefore think that we are not taking too sanguine a view when we look forward to a steady growth in our revenue. At the same time I must remind you, as I am constantly reminding myself, that unless we have a good large reserve I look with grave misgivings on telegraph property; but, as you will see, we have not trenched upon the £3,000 odd we had in hand when we readjusted our capital, and we have carried forward the full reserve that we held to be necessary when we put the plan before the proprietors and the law courts. So far our revenue, such as it is, has enabled us to do that, and for the first time, I think, for five years, to pay a dividend, and that is so far very satisfactory. I do not know that the accounts call for any special remarks. I hope our lines will continue in good order. If they continue in the condition they are in now I look forward to the Direct Spanish Company becoming as good an investment as submarine telegraph companies can be. I beg to move: "That the report and accounts now presented be, and they are hereby, received and adopted."

Mr. Edmund Etlinger seconded the motion.

Mr. David Lowe asked whether there was any chance of a cable connection being made between Carthagena and Malta.

The Chairman: We do not despair of it, but whether we shall connect at Carthagena or Barcelona is not quite clear.

Mr. Lowe pointed out that the company had made a loss of £178 in their investments, which he regarded as a somewhat serious item, and suggested whether it would not be as well to redeem their debentures from the Eastern Company by giving them a bonus on those debentures.

The Chairman: What would you pay the money out of?

Mr. Lowe said he would fall back on the reserve fund of £5,000. He thought it would be to the advantage of the company to carry out such a scheme.

The Chairman said that the question was not lost sight of by the directors, who had another scheme in their mind for dealing with it.

Mr. John Newton asked whether the dividend of 2½ per cent. was for the half-year or per annum.

The Chairman: Per annum.

Mr. Burt pointed out that by a clerical error in the sixth paragraph of the report the words "at the rate of" should have appeared in the preceding line to give the paragraph its full significance.

In reply to a shareholder, the Chairman said that 6 per cent. was paid on the debentures.

The motion was then put, and carried unanimously.

The Chairman next moved "That the preference dividend at the rate of 10 per cent., less income-tax, and a dividend at the rate of 2½ per cent. per annum on the ordinary share, free of income-tax, be now declared."

Mr. Etlinger seconded the resolution, which was carried unanimously.

A vote of thanks to the chairman and directors terminated the proceedings.

Croydon and District Electric Lighting Company, Limited.—The prospectus is now being circulated privately of this company, which is formed with a capital of £100,000 in £5 shares, for the purpose of supplying electric light within the Borough of Croydon and outlying districts. The company has entered into a preliminary contract with the Maxim-Weston Electric Company for the supply of all the necessary plant. It is stated that to ensure that this installation shall be as perfect as electrical science can now make it, the company intends to retain in a consultative capacity the services of one of the most eminent electricians of the day. The company has already received applications for installations sufficient to keep the plant contracted for in full operation as soon as it is fitted up and in working order. It is stated that the assurances of financial support are such that the directors consider proceeding to allotment a foregone conclusion, and consequently do not intend to offer any shares of the first issue in the usual manner, by advertisement. The company is promoted by the first directors, and no promotion money will be paid, nor has any sum to be paid for the use of the Maxim-Weston patents. The company thus starts unloaded with any expenses other than the bare cost of its formation.

The Eastern Extension, Australasia, and China Telegraph Company, Limited.—The accounts for the half-year ended June 30th show, subject to audit, a balance of profit of £66,655, after the payment of the interim dividend for the first quarter. The directors have now declared a dividend for the quarter ended the 30th of June of 2s. 6d. per share, free of income tax, payable October 15th, and decided to carry forward the balance of £35,405.

The Submarine Cables Trust.—The balance of £1 10s. due on the April coupon will be paid on and after the 15th inst. by Messrs. Glyn, Mills & Co., of Lombard Street, between 10 a.m. and 2 p.m. After making this payment the trustees will have a small balance in hand, which, with the income derivable from their investments for the next six months, will, it is estimated, be sufficient to pay the October coupons in

full on April 15th, 1888. The April coupons (not those for October) must be left with the bankers five clear days before calling for payment.

The Eastern Telegraph Company, Limited.—The directors announce the payment on October 14th, of a dividend of 3s. per share on the preference shares, less income-tax, for the quarter ending September 30th, and an interim dividend of 2s. 6d. on the ordinary shares, free of income-tax, in respect of profits for the quarter ended June 30th.

The Direct United States Cable Company, Limited.—The board has resolved upon the payment of an interim dividend of 2s. per share, free of income tax, being at the rate of 2 per cent. per annum, for the quarter ending 30th September, 1887, such dividend to be payable on and after the 24th October next.

United River Plate Telephone Company, Limited.—The directors have declared an interim dividend of 2½ per cent. (being 2s. 6d. per share), tax free, on the paid-up capital, payable on and after the 15th inst.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of September was 3,069, estimated to produce £2,500, against 2,675 messages, producing £2,272 in the corresponding month of last year. The receipts for the month of June, estimated at £2,750, realised £2,929.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 30th September are £2,368, as compared with £1,848 in the corresponding period of 1886. The June receipts, estimated at £5,705, realised £3,844.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending September 30th were £2,944, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Great Northern Telegraph Company, Limited. The receipts for September, 1887, £25,600; from January 1st to September 30th, 1887, £197,790; corresponding months, 1886, £195,560; and of 1885, £217,240.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for September amounted to £36,400, and to £30,107 for September, 1886; increase £6,293.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of September were £1,900, against £1,767 in the corresponding period of last year.

The Eastern Telegraph Company, Limited. The receipts for September amounted to £46,081 and to £40,778 in the corresponding month of 1886.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending 30th September are £4,450.

NEW PATENTS—1887.

12823. "Telephonic arrangements or systems for houses, offices, &c." A. A. CAMPBELL-SWINTON. Dated September 21.

12824. "System of electrical distribution." A. McEWEN. (Communicated by C. G. McEwen.) Dated September 21.

12830. "Electric lamps or lighting apparatus." W. R. LAKE. (Communicated by O. H. L. Lindemann.) Dated September 21.

12833. "Telephonic arrangements or systems for offices, hotels, &c." A. A. CAMPBELL-SWINTON. Dated September 21.

12848. "Permanent magnets for producing continuous motion." R. SCOTT. Dated September 22.

12880. "Producing solid metal sheets by electro-deposition suitable for compass cards, stencils or open worked, flat or carved articles for decorative and other uses." W. J. REYNOLDS. Dated September 22.

12883. "Producing finely-divided metal for use in secondary batteries." C. PHILIPPART. Dated September 22.

12885. "Dynamo-electric magneto-electric machines." G. E. CABANELLAS. Dated September 22.

12918. "Telegraphy." J. H. ROBERTSON. Dated September 23.

12924. "Making incandescent electric lamps; carbon rods therefor." G. ZANNI. Dated September 23.

13005. "Electrical automatic boxes for the delivery of small articles." F. VILLIERS-STEAD and OTHERS. Dated September 26.

13056. "Electro-magnetic motors." W. ALDRED. Dated September 27.

13067. "Telegraphy." F. VON RYSSELBERGHE. Dated September 27. (*Complete.*)

13080. "Dynamo-electric machines." W. FRITSCHE. Dated September 27.

13081. "Carbon filaments for electric glow lamps." J. PULLMAN. Dated September 27.

13091. "Electric meters for clocks." M. VIAN. Dated September 27. (*Complete.*)

13092. "Material for carbon filaments for incandescent electric lamps, &c." W. R. LAKE. (Communicated by A. Cruto et Cie.) Dated September 27. (*Complete.*)

13148. "Producing rectilinear or rotary motion by the aid of electricity." F. ROSS, A. FRANZEN. Dated September 28. (*Complete.*)

13154. "Applying electricity to controlling of gas and other cocks and valves." H. R. FISHER. Dated September 28.

13159. "Electro-motors and dynamo-electric machines." W. W. DUNN. Dated September 28.

13207. "Indicators for electric bells." A. MORLEY, H. W. WILSON. Dated September 29.

13219. "Incandescent electric lamps." E. BOHN. Dated September 29.

13221. "Controlling in an automatic manner reciprocatory, vibratory, or oscillatory movements of armatures and other electrical apparatus." J. H. HOLMES. Dated September 29.

13245. "Placing railway trains in communication with each other with an electric conductor separate therefrom." E. GRAEFE. Dated September 30. (*Complete.*)

13309. "Dynamo-electric machines." C. V. BURTON. Dated October 1.

13320. "Electric regulators." J. G. STATTER, S. L. BRUNTON. Dated October 1.

13325. "Electro-chemical process for the recovery of precious metals." J. NICHOLAS, H. H. FANSHAWE. Dated October 1.

13326. "Producing and administering electric shocks and currents." J. DOUGLAS, H. ABBOTT. Dated October 1.

13333. "Secondary generators, transformers, and converters of electricity." L. GAULARD and OTHERS. Dated October 1.

13338. "Electric lamp attachments." W. HARTNELL. Dated October 3.

13420. "Elements or electrodes for electric batteries." E. L. MAYER. Dated October 4.

13440. "Electric batteries." G. ZANNI. Dated October 4.

13454. "Fittings for incandescent electric lamps." R. T. TURNBULL. Dated October 5. (*Complete.*)

13480. "Electric automatic fire alarms." H. A. C. SAUNDERS, A. C. BROWN, A. W. ARMSTRONG. Dated October 5.

13509. "Telephonic apparatus." C. BELL. (Communicated by L. M. Ericsson.) Dated October 5. (*Complete.*)

13510. "Microphones." W. GENEST. Dated October 5.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

8338. "Improvements in the construction of induction apparatus." L. GUTMANN. Dated June 24. 8d. Claims:—1. The construction of layers or spirals for induction apparatus from a cable consisting of the insulated and parallel primary and secondary wires surrounded by iron wire or ribbon wound in a direction at right angles to the axis of the cable so that each unit of length of the cable gives practically the same efficiency, substantially as described. 2. The construction of layers or bobbins for induction apparatus, each said layer or bobbin consisting of one layer of primary wire and one layer of secondary wire and being provided exteriorly and interiorly with iron, substantially as described. 3. The construction of layers or spirals for induction apparatus consisting in surrounding each layer or spiral of primary and secondary wires—whether the said primary and secondary wires are in one cable or are wound separately—by iron coils formed of bobbins of iron wire or of iron ribbon in the form of a helix or of concentric iron rings or constructed out of cross shaped pieces of iron, substantially as described. 4. The construction of induction apparatus in which the iron cores are so arranged as to separate the different layers formed either from a cable containing both the primary and secondary wires or of separate primary and secondary wires, substantially as described. 5. The construction of induction apparatus, substantially as described with reference to the drawings.

9708. "New or improved apparatus for automatically making and breaking circuit for a dynamo charging accumulators, also applicable for use in running two or more compound wound dynamos in parallel circuit." A. B. HOLMES and J. C. VAUDREY. Dated July 27. 8d. Claims:—1. The method of governing a dynamo charging accumulators, or of governing each of two or more dynamos working in parallel circuit, which consists in tapping and using the shunt circuit of the dynamo in place of a special coil of high resistance, for automatically making and breaking the main circuit as required. 2. The apparatus for automatically making and breaking circuit for a dynamo charging accumulators, or for each of two or more dynamos working in parallel circuit in which the main and shunt circuits of the dynamo are used conjointly for regulating purposes, substantially as described.

10912. "Improvements in the art of applying electricity to the human body and apparatus used therefor, said apparatus being also applicable for other purposes." SYDNEY PITT. (Communicated from abroad by H. Fairbanks and W. P. Fairbanks, both of America.) Dated August 26. 8d. Claims:—1. The art of applying electricity to parts of the human body in which the muscular tissue is in a state of tension by previous, or simultaneous, independent physical effort all substantially as set forth. 2. In a machine for testing degrees of force or muscular energy the combination with the spring, upon which such force is exerted,

of an induction coil, battery, &c., and connections as and for the purposes set forth. 3. In a strength testing machine the combination with the spring upon which the force is exerted of a battery, primary and induction coil put in circuit by such pressure so as to produce an induction current, such induction current increasing with the amount of force developed all as set forth. 4. The combination of a strength testing machine, induction coil, automatic coin catching device (arranged to unlock the apparatus so that it can be operated upon when the coin is introduced) and indicator showing pounds lifted and units of electric energy developed substantially as set forth.

10926. "Improvements in the application of volta inductors or secondary generators for distributing electrical energy and for regulating alternate current motors, more particularly applicable to electrical railways." C. D. ABEL. (Communicated from abroad by the firm of Siemens and Halske, of Berlin.) Dated August 26. 8d. Claims:—1. The method of regulating the action of an electrical motor supplied from an alternate current generating machine by means of a volta inductor whose primary coils are connected to the supply circuit while the secondary coils are connected to the motor through a reversing switch so arranged as either to cause the current to pass through the coils in parallel arc or in series, or to cut one or more of the coils out of the circuit, whereby the electromotive force of the motor circuit will be varied, substantially as described. 2. In regulating the action of an electrical motor by means of volta inductors as set forth in the preceding claim the use of a resistance coil included in the primary circuit of the volta inductor having an iron core that is introduced into the coil to a greater or less extent according as the electromotive force of the motor requires to be increased or diminished. 3. In regulating the action of an electrical motor by means of volta inductors as set forth in the first claim, the use of volta inductors having their coils surrounded by two concentric split iron tubes of which the outer one is rotatable so that by turning this so that the splits of the tubes coincide to a greater or less extent the constant of induction, and consequently the tension of the current acting on the motor may be varied, substantially as described.

CORRESPONDENCE.

Reckenzaun's Secondary Battery.

In your issue of September 9th, which has just reached me, I observe two letters, one from the pen of Mr. John S. Sellon, and the other (inevitable sequel) signed "K.," both referring to an article on my secondary battery contained in a preceding number of your esteemed journal.

With a politeness, characteristic to his nature, Mr. Sellon refers to my work in connection with electrical traction, adding that I would be the first to admit the facilities offered me by the Electrical Power Storage Company. Regarding this remark I beg to say that I do not merely *admit* the favours which this company conferred upon me some few years ago, but I have taken every opportunity, public and private, to show my acknowledgment in respect thereof. With such frequency and earnestness have I advocated the good work of the Storage Company that, to this day, many people associate my name with that eminent firm, and I have to disown that honourable distinction on every occasion by saying that all direct connection ceased more than three years ago.

In the same paragraph, and without a stop to indicate the end of the sentence, Mr. Sellon quotes a claim from one of his patent specifications, as follows:—(the italics are his own) "Forming plates or retainers for secondary batteries with *interstices*, perforations, or *spaces*, which *key*, *lock*, or *firmly* retain in position the material with which the plates are packed." If Mr. Sellon will read my specification he will find that I disclaim all these points, and if he looks at my plates, or in the absence thereof, at the illustration you gave, he will see that there are no interstices, no perforations, no "spaces" in the sense meant, wherein any material could be packed, or has been packed. I am intimately acquainted with the numerous specifications of Mr. Sellon, as well as with those of many other inventors. I claim no broad principles, but merely improvements in methods of manufacture, and these were not made with a view of evading prior patents, or "getting around them," as some people might term it, by twisting words and meanings. These improvements were the result of long and careful experiments, and I applied for a patent after the advantages had been thoroughly tested. I hate patents and regard them as necessary evils.

During my experiences with electric tramcars, which date back to the year 1882, I found that the E.P.S. cells were the best in the market; they did the work splendidly. Yet I was constantly scheming or seeking for a form of battery which might be more durable and cheaper. With me and my clients it was not a question whether Mr. J. S. Sellon took out any patents in 1882, but whether the best storage battery in the market will satisfy the requirements of tramway service; whether it is sufficiently durable, cheap, capable of withstanding rough usage, careless treatment, excessive rates of discharge, and the like. The E.P.S. battery is a first-rate article, it answers the purposes of electric locomotion in so far that it can compete favourably with horse traction, though the managing director of the E.P.S. Company still doubts it. I am prepared to prove that by means of the E.P.S. battery, as constructed some time ago, the cost of haulage of tramcars can be reduced very considerably. I am also prepared to prove that my own secondary battery is cheaper than that of the Storage Company, and I am willing to put a set of my cells on a car in competition with a set of the Electrical Power Storage Company's, as at present constructed, and I believe that my plates, when doing the same work, on the same car, will last at least twice as long. This I can state after sufficient experience with my own battery.

I should be glad if the Storage Company would undertake to manufacture my plates on reasonable terms. I should be even more glad if they would themselves produce a battery better and cheaper than mine. I should feel grateful for anything that may in any way advance the science and art of electric locomotion, and I am sure that Mr. John S. Sellon would be the *last to retard* the progress of this most important industry, in spite of an antiquated, and in one single point useless patent specification. I say *useless* (limited) because I am positive that Mr. Sellon would have made *use* of a process like mine, both in his patents and in practice, had he known how to do it.

With regard to Mr. K.'s (I almost spelled his name in full) remarks I beg to say that the misapprehension he assumed to exist, must be mostly in his own mind. He says, there cannot be much expansion in the peroxide plate, and he tries to prove on paper "that there *seems* to be but a small margin for variation of bulk." I know Mr. K. has a very considerable experience with storage batteries, yet he seems to have neglected to study the effects of which he writes. When I return to London, I will, if he wishes it, show him a number of E.P.S. plates in various places, which have increased a quarter of an inch and more in width and length since they were put in operation. I will show him some plates which buckle (with careful treatment), and others that would do so if it were not for the India-rubber plugs or other expensive "separators." The importance of making the plates so that the paste cannot detach itself he will learn to appreciate when he comes to apply secondary batteries to tramcars.

A. Reckenzaun.

Philadelphia, Pa., U.S.A., *September 21st*, 1887.

The Theory of the Telephone.

The widely known and well deserved reputation of the REVIEW among scientists induces me to submit to them through the REVIEW a problem which has greatly interested me, and which I have vainly endeavoured for several years to solve.

They surely will agree with me that the tendencies of scientists of this age are in the direction of hypothesis and abstract theory. The burden of proof is strongly upon the propounders of a theory. Theorists, however, in many cases overlook the matter of the burden of proof; having put forth their theory,

they demand that it shall be either successfully controverted or accepted.

I ask myself why should we not emancipate ourselves from unproven theories, and return to the safer and more conservative, though perhaps slower, methods of experimentation and exact ascertainment of facts.

The problem which I have been endeavouring to solve, and to which I invite your attention, is "What is the true theory of the speaking telephone?"

The theory advanced by Prof. A. G. Bell, and generally accepted, is that for the reproduction of articulate speech by means of electricity it is absolutely necessary that what is termed the electric current should be unbroken and undulatory. This is the theory which Prof. Bell ascribed to his telephone, and which has been accepted, blindly, in my opinion, by scientists generally without inquiry or examination; simply, it appears because the reproduction of articulate speech by means of the Bell telephone seemed to them so astonishing, I may say, wonderful, that, in the absence of any other theory, they accepted that of Prof. Bell without submitting it to examination and experimentation.

The laws governing the production of sounds are too well known to require me to refer to them here. I, however, invite your notice to the undisputed fact that the same motions produced in the air, without regard to the means, always produce sounds similar in every respect.

I have never heard that the theory of the undulatory current for the reproduction of speech has ever undergone a thorough examination by any scientist, or has ever been established as true; and I confess that long studies of that theory have not suggested to me any means of determining its truth; for I cannot accept as proof of the correctness of that theory, the failure hitherto to reproduce speech by means of intermittent currents of electricity. I myself have great doubts as to the theory of the undulatory current advanced by Prof. Bell, from the results of numerous experiments with an instrument which I have had made according to the description and drawings of my English patent, No. 11,662, dated September 14th, 1886, lately issued.

The theory advanced by the patentee is directly opposite to that of Prof. Bell, and I have made numerous experiments to discover whether the instrument operates on what is known as the *make* and *break* circuit, and consequently by intermittent currents of electricity.

I have found that by means of this instrument having electrodes of PLATINUM, articulate speech is reproduced in an electro-magneto receiver made under my invention, patent No. 11,660, September 14th, 1886, with remarkable distinctness; but the great question is, does it act on the *make* and *break* principle; to prove or to disprove this has been the subject of numerous experiments, but I have not yet found any instrument or method for deciding that question. An examination of the construction of the instrument furnishes indubitable evidence that the tympan, when caused to vibrate must obey the laws which govern tympanic and pendulous vibrations, and therefore must *make* and *break* successively contact points placed on each side of it, provided they are sufficiently close to, but not touching the tympan when in its normal state of rest.

I have not been able to demonstrate, by any mechanical or ocular means, other than by the instrument itself, that, during the vibration of the tympan when articulate speech is reproduced by means of it, there are makes and breaks between the electrodes, nor have I been able to demonstrate that the current is undulatory.

Irrespective of the construction of the instrument, the fact that the electrodes are of PLATINUM presents to my mind strong evidence that it does operate by means of *makes* and *breaks*, because the words emitted by the receiver are *sharply* defined and *very loud*, it being well established that the variations produced in a current of electricity passing through a *microphone* having contact points made of *platinum*, are exceedingly small and incapable of producing variations of magnetism in the magnet of the receiver sufficiently great to reproduce audible sounds other than hissing, or what is termed "frying" sounds.

I submit these remarks as a matter purely of science; and I shall be very much gratified if any of your readers can suggest any method by which this interesting problem can be solved.

W. C. Barney.

New York, *September 23rd*, 1887.

The Bilbao-Santurce Tramway Company.

This company having decided to employ electric traction on all its course, I have the honour to give you particulars both as to the system to be employed and the material for that purpose.

Here are the most important data of the line:—

Length from end to end, 15 kilometres; width of line, 1·365 metre.

Maximum incline five in the hundred, extending for a distance of 150 metres; minimum curve, one of 25 metres radius.

There are 80 cars, the weight of each being 1,800 kilos. empty, and 3,800 kilos. full.

Each car is drawn by three mules of medium size and strength.

The time employed in traversing the 15 kilometres is at present 90 minutes. There are departures from the ends of the line every 20 minutes.

Here are the minimum conditions which the new electric motor must fulfil:—

1. If possible, the motor must be independent of the passenger cars.
2. It must be able to draw two or three cars, such as those of the company's, full of passengers.
3. That in this manner it must be able to traverse 15 kilometres in one hour.
4. That whilst accomplishing this work it shall not require a new electric charge in less than two or three hours.

J. Arias. E., *Director General.*

[This letter, which has only just come to hand, was addressed to the *Telegraphic Journal and Electrical Review*, New York, from whence it has been retransmitted to us. We would suggest that some of the officials of the company should spend a few days in London and watch the daily operations of the Elieson electric locomotives.—EDS. ELEC. REV.]

The Causes of Unsteadiness in Arc Lamps.

I have read Mr. de Wolffers's three column letter in your last issue, and must confess that the result of his laboured reply is somewhat disappointing to me. He commences a violent attack upon me because I venture to differ from him. The "facetious trans-Atlantic correspondent," whom Mr. de Wolffers says has classified me as an electrician "afflicted with a system," is well known to me personally. Until recently he was the Western correspondent of that well-known journal, the *New York Electrical World*, and upon a previous occasion spoke in eulogistic terms of my system. Truly he is facetious. Mr. de Wolffers then refers to my system as being the most "puffed," a statement which contains a tinge of jealousy. Let me remind that gentleman that "good wine needs no bush." But it is quite evident that Mr. de Wolffers knows very little about my system. For instance, he says that my lamp belongs to the "unctuous and much-adored dash-pot deity," and that for reasons best known to me it works with a short arc. As a matter of fact, nearly every lamp I have in operation works with an open arc, and with regard to the dash-pot I may say that, in my latest type, I use nothing but a solenoid core, or plunger, which fits nicely in the brass spool of the solenoid. Does Mr. de Wolffers class this arrangement amongst those of the "*unctuous* and much-adored dash-pot deity"? The italics are mine. Having relieved himself a little, Mr. de Wolffers grows quite

eloquent on the use of the "cow-hide," "six-shooter," "rifle-pistol," "triple-edged rapier," &c., as "the language of the Western Republic hath it." He seems to be quite at home amongst these things, more so than amongst electric lighting matters. What an *elegant* editor he would make for a newspaper out West! Can it be that he has mistaken his vocation?

After writing a whole column of what is commonly called "slosh," Mr. de Wolffers at last settles down, and says he will "begin at the beginning," and he asks me how my "hypothetical man with his hundred and fifty carbons can have anything to do with the subject under discussion." This is amusing, for Mr. de Wolffers does not see that my remarks applied to himself. "Where ignorance is bliss 'tis folly to be wise." The fact is, Mr. de Wolffers would have us believe that all the fifty million carbons made every year in the United Sates are "trash," because, forsooth, they will not produce a steady light in the particular lamps he advocates. Do Messrs. Laing, Wharton and Down or the Brush Company think they are trash? Your correspondent, Mr. FitzGerald, says that his lamps burn Brush carbons as well as Hardtmuth's cored carbons. The latter is not ashamed to show his lamps burning with American carbons, nor is anyone else, who has a reliable lamp.

Mr. de Wolffers next denies my statement—or is disposed to deny it—that the solid American carbons give a better light than the cored carbons with the same current, and, as is natural with him, jumps to the conclusion that the solid carbons were tried with a short arc. Nothing of the kind. The two carbons were tried under precisely the same conditions and with an open arc. Therefore, his denial must go for what it is worth.

In regard to the question of price, I stated most explicitly that if A could produce a *steady* light with plain American carbons, B's tender would be out of the question. Mr. de Wolffers objects to my "arithmetical exercise," and denies that plain American carbons can be purchased at half the cost of cored carbons, although he admits the latter are dearer. Of course American carbons would be dearer in France than they are in this country, on account of the duty which has to be paid. I see, also, that Mr. Cathcart states in your issue of the 23rd ult. that a firm called the Globe Electrical and Engineering Company can supply cored carbons at over 100 per cent. less than the price I named. I should very much like to try some. I am aware that there are firms who are always willing to sell cheap stuff. For instance, American plain carbons can be brought in New York $\frac{7}{16}$th in. diameter or thereabouts as low as 1 cent per foot. Freights are low, and these could be delivered here at about 3d. or 4d. per foot. This would still be less than half the price of the cored carbons named by Mr. Cathcart. I see no reason, therefore, to change my views in this respect.

When the carbon question is done with, Mr. de Wolffers then has a fling at clutch lamps. Probably this is because they are cheaper than the more complicated lamps he recommends or admires. It was only the other day that Mr. Swinburne told us that a Brush lamp "can be made to work as well as desired," and also that the "amount of overfeeding in such a lamp is microscopic." What becomes then of Mr. de Wolffers's precious statement, that the maintaining of an arc of medium length—long-open, or whatever else you may call it—is "a result absolutely unattainable with the ring clutch system." It is only by looking at Mr. de Wolffers's letter in the ELECTRICAL REVIEW for September 23rd, that one can really see what he is driving at. Personally, he does not admire the dash pot, and intends to stick to his opinions. That is just what he ought to do, *to stick to them very hard.* But what would Mr. de Wolffers have us do? He would advocate those lamps in which the arc is struck by a separate magnet, and where the feeding is effected by a shunt magnet or solenoid. Now, if there is one string which has been harped on more than another by different arc lamp inventors, it is this. It is a system which has been tried in this country and found wanting, although it was brought to its highest perfection by Mr. Brockie—who by the way *is* an authority on arc lamps. But Mr. Brockie, Mr. Crompton and many other inventors have discarded this method for the more reliable differential system. Practical experience is surely the only safe guide in these matters, and it is useless for Mr. de Wolffers to advocate, on this side of the Channel, a system of regulating the arc, which every day experience has proved to be faulty in many respects.

Charles Lever.

The Firm of Goolden and Trotter.

Mr. Goolden informs me that he has had several enquiries as to the probable prejudicial effect of my retirement on the future of his factory. He thinks that the feeling which prompted these enquiries will be increased by the statement which appeared in the *Electrician* that I designed the Goolden-Trotter dynamos.

It has always been my endeavour, since I became a principal, to give credit to whom credit is due, and on any occasion on which I have made public statements, either at meetings of the scientific societies, or in the technical journals, I have been careful, where occasion demanded it, to express my indebtedness to my staff, especially to Mr. H. W. Ravenshaw.

This gentleman, who has had a thorough training both as a mechanical engineer and as an electrician, has occupied the posts of head draughtsman and assistant manager at this factory. The duties of the former post are well understood by all trained engineers, and I have every reason to expect, that as he has assumed the managership of the factory and that the rest of the draughtsmen, junior engineers and foremen will continue without change, there is no reason why, under the future management on the lines already laid down, the business should not continue to command success.

It is a pleasure to me to record the high esteem I feel for Mr. Ravenshaw's insight into the design of dynamos, and the instinct which he appears to have acquired through spending day after day among the details of construction and winding.

Although it has not been the policy of the late firm to publish to any great extent either the methods of their manufacture, or the results of their business, I think that my share of the work is sufficiently known to give weight to my expression of goodwill.

A. P. Trotter.

October 4th, 1887.

Electro-Deposition and Decomposition of Alloys.

On reading Prof. Oliver Lodge's letter in your last issue, it at once became apparent to me that from some cause or other the letter of mine to which it referred (and which appeared in your paper of September 16th) had been misunderstood. As I am clearly responsible for this, I hasten to correct an accidental error. What I intended to convey was this: That while the Electrolysis Committee were discussing the results of Prof. Roberts-Austen's experiments on the electrolytic decomposition of metallic alloys, which I understood were of a negative character, and while they were listening to Prof. Silvanus P. Thompson's paper on the electro-deposition of alloys, it appeared somewhat strange that no one present should have noticed the fact that I had published in this journal a series of papers directly bearing upon the latter subject. These papers had no reference whatever to the electrolytic decomposition of alloys, and I regret that in my haste I inadvertently mixed up the two subjects in the letter referred to. Having thus explained the nature of the mistake to which Prof. Lodge very properly called attention, I return to my laboratory with a relieved conscience.

Alexander Watt.

London, *October 1st*, 1887.